Science Education

The Science Magazine for All Science Teachers

Formerly General Science Quarterly

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Published four times a year: in November, January, March and May
By W. G. WHITMAN, 350 Lafayette Street, SALEM, MASS.

Entered as second class matter Nov. 6, 1916, at Salem, Mass., under the Act of March 3, 1879

$1.50 a year
40c a copy

MAY, 1930

VOLUME 14
NUMBER 4

SCIENCE EDUCATION

Devoted to the Teaching of Science in Elementary Schools,
Junior and Senior High Schools, Colleges and
Teacher Training Institutions

(Formerly GENERAL SCIENCE QUARTERLY)

Vol. XIV MAY, 1930 No. 4

Editorial Notes and Comments

Abstract Section Added

Beginning with this issue *Science Education* will carry a section in which will be found abstracts of articles appearing in recent numbers of other educational periodicals, especially articles related to the teaching of science. This section will be expanded in future numbers.

Natural Science Number of Junior-Senior High School Clearing House

Readers of *Science Education* will be interested in the April, 1930 issue of Junior-Senior High School Clearing House which is devoted to Natural Science. The issue is of such importance that we give below the titles of articles and the names of the authors. Copies of the magazine may be obtained for 40 cents each, by writing to the Publication and Business Office of the journal at 32 Washington Place, New York City.

CONTENTS

NATURE TRAINING SCHOOL OF THE COORDINATING COUNCIL ON NATURE ACTIVITIES

A committee selected from several of the associations of co-operating organizations of the Coordinating Council on Nature Activities will conduct a Nature Training School from June 7 to June 20, at Camp Talualac and Camp Akiwa in Interstate Park, Arden, New York. The schedule of courses and activities includes geology, plant study, animal life (general), insect life, nature photography, music, art, special field trips, camp fire discussions, and astronomy. The program of activities is in charge of Bertha Chapman Cady and Vernon M. Cady. Mr. Fay Welch is chairman of the committee.

JULY MEETING OF THE DEPARTMENT OF SCIENCE INSTRUCTION OF THE NATIONAL EDUCATION ASSOCIATION

The summer meeting of the National Education will be held at Columbus, Ohio. The theme of the meeting will be "Vital Values in Education." At this meeting the School Garden Association of America will have a program on Monday afternoon, June 30. On July first and second the Department of Science Instruction offers the following program:

DEPARTMENT OF SCIENCE INSTRUCTION

President, E. Laurence Palmer, Director of Nature Education, Cornell University, Ithaca, N. Y. Secretary, Ralph K. Watkins, Associate Professor of Education, University of Missouri, Columbia, Mo.

FIRST SESSION

Tuesday, July 1, 2:00 P. M., Heaton's Music Store

The Place of Science Instruction in General Elementary School Program. O. G. Brim, Professor of Elementary Education, Ohio State University.

Motion Pictures as a Vehicle of Instruction in Elementary Schools.

Dr. Thomas Finegan, Eastman Teaching Films, Rochester, New York.

SECOND SESSION

Wednesday, July 2, 2:00 P. M., Heaton's Music Store

Vital Values of Science Instruction to be found in Text Books.
Dr. Benjamin C. Gruenberg, 18 East 48th St., New York City

The Essentials of Planning a Science Program for Secondary Schools.
Earl R. Glenn, Professor of Physics, New Jersey State Teachers College, Upper Montclair, N. J.

The Essential Values of Science Tests in High School.
Thomas L. Bayne, Assistant Professor of Rural Education, Cornell University, Ithaca, N. Y.

Essential Elements Involved in the Training of High School Science Teachers.
Charles J. Pieper, New York University, New York City

Vital Values being Developed Through Recent Research in Science Instruction Concerned with Methods of Teaching.
Ralph K. Watkins, Associate Professor of Education, University of Missouri, Columbia, Mo.

SUMMER COURSES FOR SCIENCE TEACHERS

The attention of science teachers is called to those pages of this issue which give a list of courses for science teachers to be offered during the coming summer session in various teacher-training institutions. Obviously it would be impossible to make such list all inclusive. The list represents those institutions which replied to a questionnaire recently sent to them.

CO-OPERATION

The amount of material which *Science Education* can publish depends upon income. You are able to help increase that income, first, by patronizing our advertisers, letting them know that you are interested in the success of *Science Education,* and second, by securing new subscribers.

The Place of the Science Workroom in the Elementary School Program

Gerald S. Craig

Instructor of Science, Horace Mann Elementary School; and Assistant Professor of Natural Science, Teachers College, Columbia University

A superintendent in a large city system recently asked the following question. "Shall I plan a science laboratory in the new elementary school buildings that we are erecting in our city next year?"

Many school systems are answering this question in the affirmative. A number of blue-prints of buildings to be erected in the near future require the setting aside of one and, in some cases, two rooms for science. Other schools are remodeling one or more of their regular classrooms for science purposes.

Within the last century the science lecture room and laboratory have become firmly established as fundamental equipment for both the college and the high school. Are there now indications that the elementary school is in the process of evolving a special science workroom or laboratory? The public has a right to demand what purpose the science center in the elementary school can serve. The administrator planning such a center must be sure that it is built to justify the additional expense and outlay. Possibly most important is the necessity of the administrator knowing what demands are made on his instructional staff. Will he need to hire an additional teacher who is to be specialist in science? What are the methods in practice of administrating instruction when there is a special center for science in each elementary school laboratory?

Many have assumed that the high school laboratory in a diluted form should be introduced into the elementary school. Such a movement or tendency may prove to be a serious mistake. One may introduce the most elaborate equipment and program, yet if that equipment and program does not benefit the child, it is in vain. The equipment of the elementary school workroom must be selected on the basis of its contribu-

tion to the boys and girls of the elementary school and not on the basis of past tendencies in the special sciences of the high school. The major portion of the equipment of high school biology, physics, and chemistry has little part in the instruction of boys and girls in grades 1 to 6.

THE PURPOSE OF THE SCIENCE WORKROOM

Two large opportunities should be kept in mind in equipping the science workroom. The first opportunity is that of assisting in the teaching of the elements of learning set forth in the elementary science course of study. This might be called the required or core content. The second opportunity is that of encouragement of individual and group interest. This latter would include provision for science and nature clubs as well as other individual and group extra-curricular activities. With these two things in mind we might enumerate the purposes of the science workroom as follows:

1. To provide an environment which will render a setting compatible with readiness for learning the elements set forth in the course of study.
2. To demonstrate the elements of learning set forth in the course of study and make them acceptable to the learner.
3. To provide for experiences which give exercise and drill for the elements of learning set forth in the course of study.
4. To give opportunity for student participation in construction, assembling, caring for, and amplifying the materials of instruction.
5. To develop and maintain the individual and group interest and activities in science.

GUIDING PRINCIPLES IN PLANNING THE SCIENCE WORKROOM

The workroom should be equipped in such a way as to assist in giving children such instruction as comes from a well-balanced experience with science. Many so-called nature rooms only assume that the plant and animal phases of science have any contribution to the life of the child. They deny the value of acquaintance with many of the most worth while and interesting meanings and principles of science. The meanings of elementary science are derived from the basic sciences — astronomy, biology, chemistry, geology, and physics. The equipment of the workroom should provide for a balanced

learning of the elements which are a part of the elementary school curriculum and which are derived from the basic sciences. The practice of providing only for experience with plants and animals is not justified on the basis of any reputable curriculum study. Children need to learn the meanings that are essential parts of the principles that are secured from the study of the air, stars, electricity, as well as of plants and animals. The tendency in elementary science is definitely towards a well-balanced science and away from a study derived from a small segment of science.[1]

The second important feature is to consider the relation of the workroom to the instruction that is carried on in the regular classrooms. It is important to determine the means by which the equipment and instruction of the workroom can reach and motivate the instruction of the classroom.

There are three chief types of instruction which should be evaluated in terms of the elementary school program in its relation to the science workroom.

1. DEPARTMENTALIZED ORGANIZATION OF INSTRUCTION.

There is a tendency for some school systems to introduce departmentalized instruction. In this case all of the instruction in the various subject fields is given by specialists. The children are always taught science in a special period of science and by a specialist. The children would always go to the laboratory or workroom for this instruction. Integration of science with the other subject fields is entirely at the discretion of the specialist. This type of organization of instruction is in disfavor with many elementary school leaders because they feel that each subject matter field is locked away in a water-tight compartment. It is contended by them that the children will not see the relation of the learning in science with that of the other subjects.

One great advantage of the departmentalized plan is that the specialist having but one field to teach would have a better opportunity to become expert in it than would the classroom teacher who has many fields of endeavor. The instruc-

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1 Examination of recent courses of study reveals the tendency towards a balanced course: Baltimore, New Jersey, Horace Mann, New York, St. Louis, Cleveland.

tion would tend to be more accurate and would contain less misconceptions and distortions.

2. THE SINGLE CLASSROOM TEACHER ORGANIZATION OF INSTRUCTION.

The second tendency which is by far in the majority is that of the single classroom teacher. In this case the classroom teacher is responsible for all the instruction in science along with the other subjects.

This type has its advantages as well as its disadvantages. One advantage is that the classroom teacher can more easily integrate science with the other subjects than can the department specialist. The children feel more at home in their own classroom. Science can be woven in with many subjects. It can become a part of the entire school program — not something which is studied only in a laboratory set aside for science.

There is one disadvantage in this type of instruction and so serious it is in nature as to warrant major attention of the worker in science education. Teachers as a whole in the elementary school are not prepared to teach science. It appears at the present time that children are capable of accomplishing so much more in science in the elementary school than the classroom teachers are qualified to teach. This is due to some extent to an inadequate program of teacher training. The course in most normal schools is too short to train teachers to become experts in all of the subjects she is expected to teach.

Does this mean that the elementary science program, while apparently feasible as far as the child is concerned, must mark time for the present because classroom teachers are inadequately trained for the task, and because it may be some time before normal schools will be graduating teachers trained to teach science in sufficient numbers to remedy the plight to any great extent? While recognizing the difficulties it is safe to assume that we have at our disposal a program which has been successful where it has been tried and promises a way out of the dilemma. This is proposed as a third type of organization of instruction. It utilizes advantages from both the departmentalized and the single classroom teacher organizations with the avoidance of certain of their disadvantages.

3. FUSION OR MODIFIED ORGANIZATION OF INSTRUCTION.

In this organization both classroom teacher and specialist are responsible for the instruction. Instruction in science is conducted in both the science laboratory and in the regular classroom. The classroom teacher goes with the children to the laboratory when she cannot conduct the instruction in the classroom. This journey to the laboratory may be due to the fact that the teacher lacks the background necessary to direct certain activities or instruction or to teach some phase of the subject.

This type of organization of instruction has been used for several years in the Horace Mann Elementary School, Teachers College, Columbia University. The classroom teacher has at hand a course of study. The course of study sets forth certain goals for her grade. Some of these she may feel qualified to teach without assistance. On some she may only need such help as comes from a conference with the specialist. She may be directed by the specialist to certain readings, experiments, materials, or activities both for herself and the children. One conversation with the specialist may mean the planning of instruction that may run for several weeks. In still other cases it may be necessary for the specialist to help with the instruction. Such instruction is probably done in the laboratory or workroom where the materials are available. The instruction in this case is distinctly not to be confined to the four walls of the science laboratory. The elementary teacher goes to the laboratory with the children. She can learn with the group. The specialist and the classroom teacher decide what shall be the assignment. Sometimes thirty minutes in the laboratory frees sufficiently the difficulties to permit the classroom teacher to carry on with the group in science for several weeks with no further assistance from the specialist.

In this organization the classroom teacher relinquishes no control over the instruction. This is especially important in the primary grades. Mrs. Meadowcroft, First Grade teacher in Horace Mann, keeps the instruction in her hands even while the specialist is attempting to clarify some point for the children. The classroom teacher having more acquaintance with the children can assist greatly in directing the lesson and preventing the specialist from plunging into intricate

phases of scientific phenomena. In this procedure the specialist learns a great deal about presenting science for the lower levels.

One will readily notice that the modified plan as outlined here differs greatly from the departmentalized plan. In the departmentalized plan the classroom teacher need not be with her children during the instruction that is carried on by the specialist. Under the fusion plan the classroom teacher is required to accompany the children to the laboratory. She is responsible for the year's outcome in science. She must know what the group needs. She must be familiar with the accomplishment set forth in the course of study and be able to determine the needs of the group. She is responsible for science as it is carried on in her classroom. She is responsible for linking the learning in science with the everyday experiences of the children.

The specialist in turn needs not only to have an excellent background of science but he should have the ability to teach children. He needs to be able to advise the teachers in the problems of teaching science. He should know where to secure the materials of instruction such as exhibits, slides, films, etc. In a sense he is a teaching supervisor.

THE MODIFIED PROGRAM AS A MEANS OF TRAINING IN SERVICE

The specialist becomes an agent in training in service. The teacher should not go for assistance on the same point year after year. A good teacher learns how to teach more and more of the science for her grade. In this way has there been training in service. The specialist has not only met the immediate needs but he is increasing the efficiency of instruction by training the teacher to teach science.

The workroom is the center where the specialist is found. It is the central headquarters for science activities for the school. It should be a place for display and storage of science materials. It is hardly necessary to say that properly equipped, the laboratory can be the most attractive place in the entire school for the children.

The laboratory should provide an environment which will stimulate children's interest in science. The child interested in any particular phase of science should have an opportunity to follow that interest. If the child is interested in collect-

ing moths, he should find in the laboratory a workshop for such activity. If he is interested in electricity he should be permitted to work along the line of his interest. The laboratory in itself should stimulate the interest of the children along the wide variety of elementary interests in science.

It is common knowledge that American schools are not excelling in the matter of field excursions.[2] This is due in part to the fact that the teachers have not been trained to conduct such excursions. The specialist should be trained to conduct such trips. On these excursions the group and specialist should be accompanied by the classroom teacher. The classroom teacher can then see that the learning of these excursions can be continued after the group has returned to the regular classroom.

Summary

1. Many school systems are adding science laboratories or workrooms to the regular equipment of the elementary school.
2. It is recommended that this workroom be planned to give the children a balanced experience in science.
3. The equipment of the workroom will be described in later articles. The equipment should be selected on the basis of the objectives of elementary science.
4. It is recommended that administrators plan to hire a subject-matter specialist. The specialist would be in charge of the workroom.
5. The specialist and the workroom can serve as agents in the training of classroom teachers to teach science. This can be made into an important step in the development of elementary science during the interim when elementary teachers are poorly trained in this field.

NOTE.—This is the first of a series of articles dealing with the elementary science laboratory. Subsequent articles will be as follows:

1. Floor Plans for the Elementary Science Workroom, by Goldie Johnson, Supervisor of Elementary Science, Montclair, New Jersey.
2. The Biological Equipment for the Elementary Science Workroom, by Jessie Sickels, Rochester, New York.
3. The Physical Equipment for the Elementary Science Workroom, by George W. Haupt, Instructor of Science in the Horace Mann Elementary School.
4. School Nature Rooms, by Marjorie Coit, Director of the School Nature League, Museum of Natural History, New York City.

2 See "Natural Science Education in the German Elementary Schools." Lois Meier. Contribution to Education, Teachers College, Columbia University.

Success in Physics and Chemistry in Relation to General Science and Biology

HARRY A. CARPENTER
SPECIALIST IN SCIENCE, ROCHESTER, N. Y.

General science or biology and physics or chemistry are required for graduation from the Rochester High Schools. Students who enter the senior high school as first year pupils have been required to take biology five 45-minute periods per week for the year. This group of pupils will later be referred to under the 8-4 plan. Other pupils enter the senior high school as 10th grade pupils by way of the junior high school. These pupils have had general science training two 50-minute periods per week in the 7th grade, two 50-minute periods per week in the 8th grade, and four 50-minute periods in the 9th grade.

This investigation was undertaken to determine to what extent, if any, the general science pupils were more interested in science than those having had biology and to what extent, if any, they were better trained in science as indicated by the results of their work in physics and chemistry.

The following data are by no means considered final, yet they seem to warrant the tentative conclusion that students who have had the general science do better work in physics and chemistry and are more interested in science than are students of reasonably corresponding intelligence and environment who are trained in elementary biology.

For this study the data are limited for the most part to those students who graduated from the West High School in the six graduating classes — January and June 1926, January and June 1927, and January and June 1928. The number of students considered in the major part of the study is 938. Graduates of the West High School were selected for the study because there were no serious racial or environmental differences in students coming from either the grammar schools or the junior high schools.

The following comments are appropriate for the fair consideration of the data presented and the tentative conclusions suggested. In the first place it should be noted that between the completion of work in general science at the end of the

9th grade or biology in the 9th grade, and the starting of physics or chemistry at the beginning of the 11th grade there is a period of one year during which time these pupils are practically debarred from taking any science because of the second foreign language and history requirements. In the second place it should be noted that as a rule no student is allowed to take physics or chemistry until he has completed a year's work in plane geometry or its assumed equivalent in the case of commercial students. Thirdly it should be stated that practically no attention is given to work in electricity in our general science work and very little attention to work on simple machines. On the other hand certain biological aspects of the children's environment are given reasonable emphasis and topics of a physiographical and astronomical nature receive some attention.

In view of the above facts it seems fair to assume that any gain in the study of the physics and chemistry as a result of general science versus biology is due to the development of certain desirable attitudes, method of study, and interest rather than as a direct result of memorized and duplicated material.

Three studies are included in this report, the first of which led to the further investigations:

A. A comparison of examinations results in physics and chemistry based on general science preparation and biology preparation.

B. A comparison of school term records of graduates of West High School on the basis of general science preparation and biology preparation.

C. A study of the sciences taken by the same graduates.

A.

COMPARISON OF EXAMINATION RESULTS IN PHYSICS AND CHEMISTRY BASED ON GENERAL SCIENCE PREPARATION AND BIOLOGY PREPARATION

The chemistry and physics examinations referred to in the table A-1 are local tests covering the first semester of work in each subject. Many of the questions of these tests had been used in previous tests and considerable data as to their reliability determined.

Inspection of the data (Table I) shows that students completing the first semester of chemistry and physics in June 1928, who came through the junior high school with general

science training, attained medians significantly higher than those students who had had the biology preparation.

TABLE A-1. PHYSICS AND CHEMISTRY EXAMINATION RESULTS AS AFFECTED BY PREVIOUS SCIENCE TRAINING

	Chemistry Term June 1928 Total Score 99		Physics Term June 1928 Total Score 60		Chemistry Term Jan. 1929 Total Score 112		Physics Term Jan. 1929 Total Score 87		Physics Term Jan. 1929 Total Score 68	
	No. Pupils	Median	No. Pupils	Median	No. Pupils	Median	No. Pupils	Median	No. Pupils	Median
6-3-3 Plan Preparation	170	60	87	46	190	74	50	59	73	48
8-4 Plan Preparation	55	50	32	45	76	65	26	53	15	39

The students of January 1929 with chemistry under the 6–3–3 plan had higher medians than under the 8–4 plan. This is also true of the physics students of January 1929. In this latter case different tests were given in different schools, indicated by the difference in total scores. In both of these cases, however, pupils under the 6–3–3 plan did work superior to that done by pupils under the 8–4 plan.

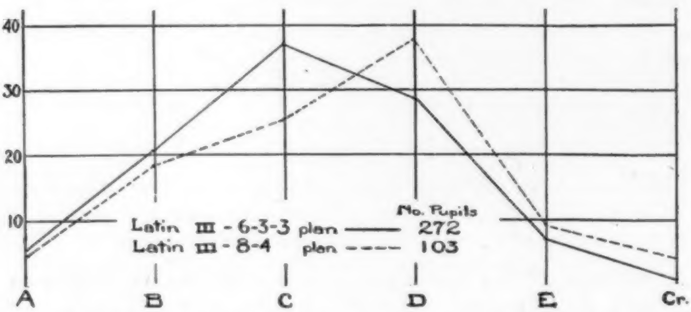
These data clearly indicate that general science as developed in Rochester contributes more to the work in physics and chemistry than does the work in biology as measured by examination results.

B.

COMPARISON OF SCHOOL TERM RECORDS OF GRADUATES OF WEST HIGH SCHOOL ON THE BASIS OF GENERAL SCIENCE PREPARATION AND BIOLOGY PREPARATION

In view of the fact that current examination results in physics and chemistry indicated superior work in physics and chemistry by students who had general science preparation as compared with biology preparation, it seemed desirable to make a study of the school records of a large number of graduates since more students would be involved and since the school record is a summary of the average class work done by a pupil and his final examination record. Conclusions based on school records would, therefore, appear to be more reliable than conclusions based on examination results only.

A preliminary study of a certain number of graduates was made which resulted in data appearing to warrant the same conclusions as had been drawn from the study of examination results. The question was raised, however, as to whether or not the apparent superiority of students in physics and chemistry with general science preparation might not after all be part and parcel of the result of junior high school training in general as compared with the 8–4 plan. It seemed necessary, therefore, to determine to what extent, if any, the junior high school pupils have in fact done superior work to those of the 8–4 plan as indicated by school records in core subjects. If they have done superior work, then the problem is to determine to what extent, if any, gains in physics and chemistry are of the same order as gains in the other subjects in which case the gain could not be claimed specifically because of general science training but rather would be due to the general junior high school education. If, however, the gain in physics and chemistry can be shown to be more or less than the gain in the other core subjects, then it may fairly be concluded that the general science preparation functions to that extent better or poorer than biology.

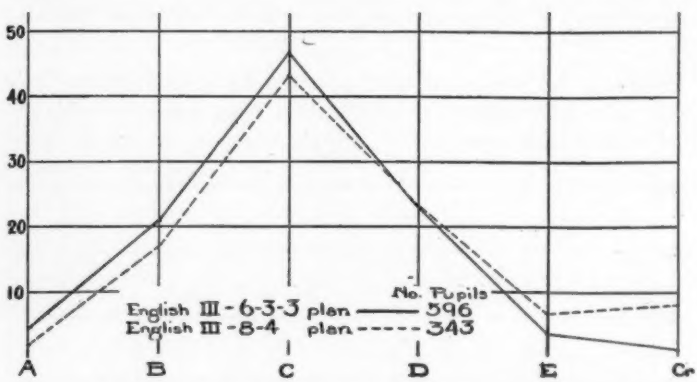


GRAPH B-1: TERM RECORDS of the graduates of the classes of JANUARY 1926-JUNE 1928 in LATIN III, comparing the work of the pupils having JUNIOR HIGH preparation (6-3-3 plan of organization) with that of those coming direct from the GRAMMAR SCHOOLS (8-4 plan of organization).

All of the 938 students considered in this study are bona fide graduates of West High School and all but seven took physics or chemistry, or both. The other subjects chosen for

consideration are English 3rd year, taken by all students considered; Latin 3rd year; and intermediate algebra. 594 pupils had had general science preparation in the junior high school and 337 had had elementary biology instruction in this high school under the 8–4 plan. The number of records involved in calculating percentages is approximately twice the number of pupils since both term and final records are used.

Intelligence scores are not available for all of these students. It is assumed, however, that inequalities in intelligence largely have been eliminated due to the fact that a large proportion of the slow students drop out of school during the 10th year and to the fact that the students taking three years of Latin and intermediate algebra will have average intelligence where racial differences and environment are not great. It must also be remembered that only graduates are considered.

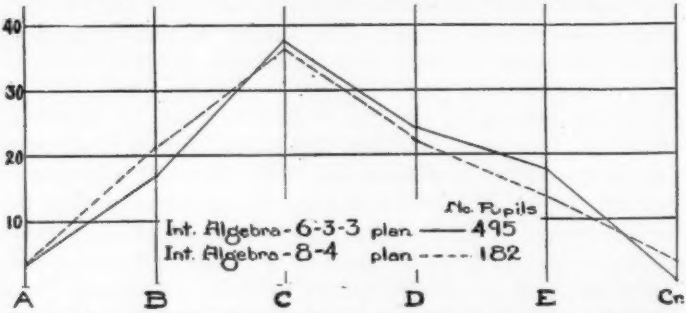


GRAPH B-2: TERM RECORDS of the graduates of the classes of JANUARY 1926-JUNE 1928 in ENGLISH III, comparing the work of the pupils having JUNIOR HIGH preparation (6-3-3 plan of organization) with that of those coming direct from the GRAMMAR SCHOOLS (8-4 plan of organization).

Inspection of the above graphs for Latin 3rd year (B-1), English 3rd year (B-2), and intermediate algebra (B-3) below show significant gains in Latin and English for pupils on the 6–3–3 plan as compared with the work of pupils under the 8–4 plan. In intermediate algebra the work appears to be about equal under either plan.

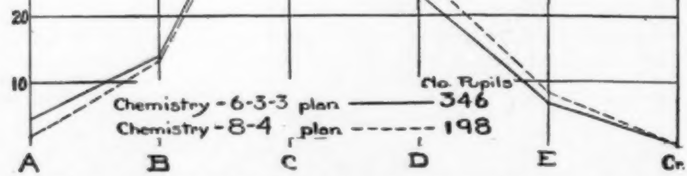
It should be noted that for the grades (records) A, B, and

C, superiority is indicated when one graph is above the other but on grades D and E superiority is indicated when one graph is below the other. On each of the graphs appears "Cr" which



GRAPH B-3: TERM RECORDS of the graduates of the classes of JANUARY 1926-JUNE 1928 in INTERMEDIATE ALGEBRA, comparing the work of the pupils having JUNIOR HIGH preparation (6-3-3 plan of organization) with that of those coming direct from the GRAMMAR SCHOOLS (8-4 plan of organization).

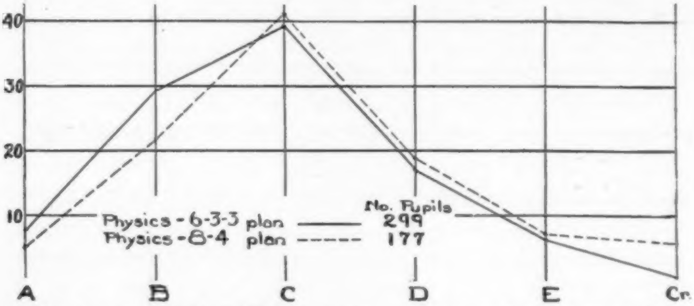
indicates the percent of students who have received credit in the particular subject by certification from schools outside the city in which case credit only is granted, no grade being



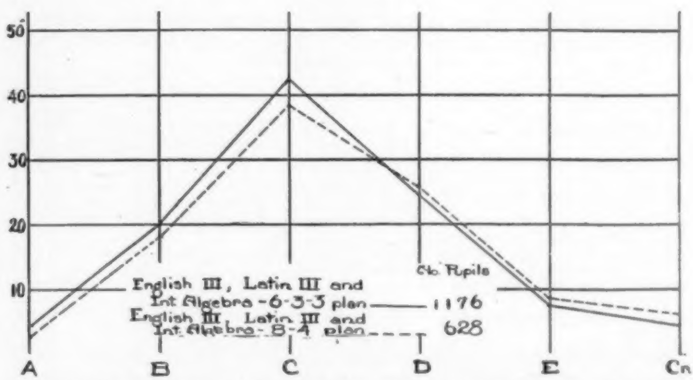
GRAPH B-4: TERM RECORDS of the graduates of the classes of JANUARY 1926-JUNE 1928 in CHEMISTRY, comparing the work of the pupils having JUNIOR HIGH preparation (6-3-3 plan of organization) with that of those coming direct from the GRAMMAR SCHOOL (8-4 plan of organization).

attached. It should be noted also that a small spread between graphs represents a significant number of pupils.

Graphs B-4 and B-5 show the comparative results of those students who took chemistry and those who took physics compared on the basis of the 6–3–3 plan and the 8–4 plan.



GRAPH B-5: TERM RECORDS of the graduates of the classes of JANUARY 1926-JUNE 1928 in PHYSICS, comparing the work of the pupils having JUNIOR HIGH preparation (6-3-3 plan of organization) with that of those coming direct from the GRAMMAR SCHOOLS (8-4 plan of organization).

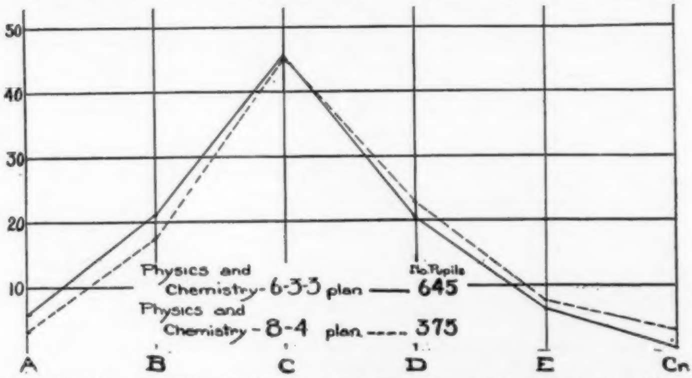


GRAPH B-6: TERM RECORDS of the graduates of the classes of JANUARY 1926-JUNE 1928 in the subjects listed to the left, comparing the work of the pupils having JUNIOR HIGH preparation (6-3-3 plan of organization) with that of those coming direct from the GRAMMAR SCHOOLS (8-4 plan of organization).

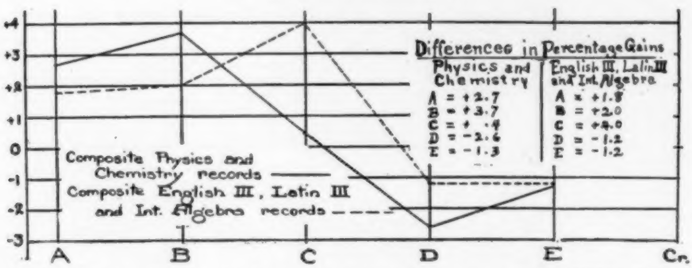
From these separate graphs it is difficult to determine degrees of differences in superiority; therefore, composite graphs and tabulations are shown, one (B-6) being the composite graph for English 3rd year, Latin 3rd year, and intermediate

algebra, and the other (B-7) a composite graph of the chemistry and physics compared on the 6–3–3 plan and the 8–4 plan.

Inspection of these two composite graphs or the accompanying data seems to demonstrate the superiority of the junior-



GRAPH B-7: TERM RECORDS of the graduates of the classes of JANUARY 1926-JUNE 1928 in the subjects listed to the left, comparing the work of the pupils having JUNIOR HIGH preparation (6-3-3 plan of organization) with that of those coming direct from the GRAMMARS SCHOOLS (8-4 plan of organization).



GRAPH B-8: Difference in percent of improvement in SENIOR HIGH records of the graduates of the classes of JANUARY 1926-JUNE 1928 at West High School, comparing the work of the pupils having JUNIOR HIGH preparation (6-3-3 plan of organization) with that of those coming direct from the GRAMMAR SCHOOLS (8-4 plan of organization); as shown by a composite of the PHYSICS and CHEMISTRY records and a composite of the ENGLISH III, LATIN III, and INTERMEDIATE ALGEBRA RECORDS. (The O-line of reference represents the 8-4 plan of organization.)

senior plan as shown by results in the subjects mentioned, when compared with the traditional 8–4 plan, but does not make apparent at once the extent, if any, to which the general

science preparation may be superior to the biology. Therefore, a graph (B-8) is shown comparing the gains in improvement in the composite chemistry-physics results as compared with the composite English-Latin-intermediate algebra records. These graphs show that the gain in physics and chemistry is definitely greater than the gain in English, Latin, and intermediate algebra. It may be inferred, therefore, that this gain in physics and chemistry is due to the general science preparation since other variables are eliminated.

C.

A STUDY OF THE SCIENCES TAKEN BY THE SAME GRADUATES

Tables C-1 and C-2 show the sciences and combinations of sciences taken by members of the graduation classes, January 1926 to June 1928, under the 6–3–3 plan and 8–4 plan of organization respectively. The table C-2 shows also the sciences taken by seven students who for one reason or another had not taken either general science or biology. Zoology and physiology were taken by only two students in each case, who were transfers to this school from other cities. Other sciences were taken here. Table C-3 is a summary of tables C-1 and C-2 showing the number of students taking each science indicated.

TABLE C-1. 6-3-3 PLAN OF ORGANIZATION.

Combinations of General Science and other sciences, as taken by 594 boys and girls at West High. These were all members of the classes of January 1926-June 1928. The General Science was taken in the junior highs (in most cases Madison or Jefferson). In almost every case it was preceded by science work in the 7th and 8th grades.

	Boys	*Girls*	*Total*
General science	1	0	1
General science and physics	151	59	210
General science and chemistry	15	233	248
General science and physical geography	2	0	2
General science, physics, and chemistry	41	9	50
General science, physics, and physical geography...	25	6	31
General science, physics, and botany	2	1	3
General science, chemistry, and physical geography	9	18	27
General science, chemistry, and botany	0	13	13
General science, physics, chemistry, and phys. geog.	7	0	7
General science, chemistry, botany, and phys. geog.	1	0	1
General science, physics, botany, and phy. geog. ...	1	0	1
Totals	255	339	594

The inference might be drawn from table C-3 that physics is preferred to chemistry by boys and that chemistry is preferred to physics by girls. However, such inferences should

TABLE C-2. 8-4 PLAN OF ORGANIZATION.

Combination of Biology and other sciences, as taken by 337 boys and girls at West High School. These were all members of the classes of January 1926-June 1928.

	Boys	*Girls*	*Total*
Biology	2	0	2
Biology and physics	75	30	105
Biology and chemistry	6	114	120
Biology, physics, and chemistry	22	8	30
Biology, physics, and physical geography	22	5	27
Biology, physics, and botany	0	1	1
Biology, chemistry, and physical geography	5	25	30
Biology, chemistry, and botany	0	5	5
Biology, advanced biology, and physical geography	0	1	1
Biology, physics, chemistry, and physical geography	11	1	12
Biology, physics, chemistry, and botany	1	0	1
Biology, physics, physical geography, and physiology	1	0	1
Biology, chemistry, physical geography, and botany	0	1	1
Biology, physics, physical geography, and zoology	0	1	1
Totals	145	192	337

	Boys	*Girls*	*Total*
Physics	0	1	1
Chemistry	0	2	2
Physics and chemistry	1	0	1
Physics and physical geography	1	0	1
Physics, chemistry, phys. geography, and physiology	1	0	1
Chemistry, physical geography, zoology, and botany	0	1	1
Totals	3	4	7
Grand totals	148	196	344

TABLE C-3. SUMMARY OF SCIENCES TAKEN.

Boys		*Girls*	
Physics	362	Chemistry	430
Chemistry	121	Physics	128
Physical Geography	86	Physical Geography	58
Botany	5	Botany	22
Physiology	2	Zoology	2

not be drawn inasmuch as boys who are taking the commercial course have been advised to take physics and commercial girls have been advised to take chemistry.

Table C-4 shows the percentages of boys and girls taking one or more years of science based on the sciences actually taken for credit by members of the graduating classes of January 1926 to June 1928.

The reason for the low percentages for students taking one science is due to the fact already stated that two years of science are required for graduation. The figures in C-4 show considerable divergence in the election of more than the required amount of science as referred to biology-prepared

TABLE C-4. SUMMARY OF PERCENTAGES OF PUPILS OF THE GRADUATING CLASSES OF JANUARY 1926-JUNE 1928.

These pupils took one science—biology or general science—or a combination of sciences. In this table comparison is made between those who took general science in the junior high and those who took biology in the senior high school. This 9th year science work was preceded for the most part by three or four terms of science, two periods each week in the 7th and 8th grades.

Numbers of Sciences taken	Boys		Girls		Both	
	Biology	Gen. Sci.	Biology	Gen. Sci.	Biology	Gen. Sci.
1	1.4	.4	0.0	0.0	.5	.2
2	55.8	65.9	75.0	86.2	66.7	77.5
3	33.8	30.2	23.4	13.9	27.9	20.9
4	8.98	3.5	1.6	0.0	4.7	1.5

TABLE C-5. PERCENTAGES OF PUPILS ELECTING EXTRA YEARS OF SCIENCE.

Graduating Class	Biology Preparation	Gen. Science Preparation
January 1926	39.8	12.0
June 1926	40.9	12.2
January 1927	44.4	19.8
June 1927	24.1	23.6
January and June 1928	23.6	29.7

students and general science prepared students. Table C-5, however, which shows the number of students electing more than the required amount of science by years indicates clearly that the trend is in favor of general science preparation since the biology prepared students taking more than the required science are decreasing in percentages whereas the students who had general science preparation are taking extra science in increasing percentages.

TENTATIVE CONCLUSIONS

Consideration of all the above data indicates:

a. That students with general science preparation throughout the seventh, eighth, and ninth grades of the junior high schools do superior work in physics and chemistry to students with biology preparation.

b. That students with general science training become more interested in science as evidenced by their election of science courses in addition to the requirements and by superior grades.

c. That the superior work and interest of general science pupils is not likely due to duplication and memorization of facts and may, therefore, be due to specific training values and attitudes that are carried over the span of years.

The New Jersey Nature Study and Elementary Science Course of Study[1]

G. V. Bruce
Summit High School, Summit, N. J.

One of the major objects of education is to acquaint the oncoming generation with the various fields and categories into which humans have found it convenient to classify their knowledges. This calls for a plan, a curriculum, which will set forth the categories to be included and in turn a course of study under each to provide a core of knowledge which may be acceptably considered as contributory to that particular category. With all this perfected, it remains still for the teaching process to seek to build up not only a series of knowledges, but to emphasize as well those less ponderable, yet equally important attributes of learning, namely, habits, attitudes, appreciations and skills.

In building educational curricula it is often necessary to depart from the classifications of the subject specialist and re-cast human knowledge into other categories which will better meet the intellectual needs of the various academic levels. In the earlier grades, with which this discussion is concerned, the lives of the children are largely sensory and adjustments to environment mechanical. Their intellectual activities are limited largely to that of observation, to the gathering of facts and sense perceptions, and to processes of objective thinking. At this level the curriculum must give the pupil an opportunity to come in contact with a great number of things, and a great variety of situations. In other words, they must have a great profusion of skilfully organized sensory contacts provided for the enrichment of their experience. To provide this the curriculum must be limited to categories few in number and broad in scope. It is believed by the thinkers in the field that the schools of the future will be limited to probably three; first, the fundamentals and skills including the vernacular and number; then the social sciences including history, citizenship and geography; and finally natural physical

1 Presented at the meeting of the National Council of Supervisors of Elementary Science at Atlantic City, February, 1930.

science. It is this latter with which we are here primarily concerned.

It is well known that children are coming up through the undifferentiated work of the elementary school with a very inadequate knowledge of how to deal with natural phenomena. They are comparatively much less equipped in this than they are in the other large fields into which humans have classified their knowledge.

The Department of Public Instruction of the State of New Jersey has for a number of years recognized this as a deficiency, and last year set out to provide the necessary core of knowledge as the first essential step toward placing science education in the curriculum with an emphasis equal to the other fields. It has taken the form of the Monograph entitled "The Teaching of Nature Study and Elementary Science." It provides a body of knowledge and a series of activities for all grades from kindergarten to the eighth.

The work was carried on by a committee of representative teachers selected from different parts of the state under the direction of M. Ernest Townsend, then Assistant Commissioner in charge of Elementary Schools.

At the first meeting of the committee a cursory glance at the problem was sufficient to convince the less optimistic members of the stupendous nature of the task before us. The widely scattered nature of the committee greatly intensified the difficulties. It prohibited the possibility of frequent conference necessitating much to be done by the laborious process of the mails. It allowed little or no opportunity for experimentation during the formative stages. In this absence of a process of intensive application, of regular conference and experimentation, the work is bound to possess crudities. I am mentioning these physical handicaps partly in the way of alibi and partly by way of apology for the many imperfections of the work.

A job of this kind cannot be clearly understood without the reasons back of it. To give an idea of the nature of the work it might prove most fruitful to reveal the thinking of the committee. In this connection it will be helpful to think of the deliberations as divided into three stages. The first

was that of catching a vision of the task. The second stage embodied the formulation of a plan of organization. And the third stage, the actual consummation of the work.

There was the need for a vital vision which in the process of selecting, grading and organizing the material and activities would keep us on a steady course. We tried to catch a vision of the youth in the midst of a strange and unexplored world. We pictured him there surrounded by all the elements of his natural environment, the sky, the earth, the water, and all the living and non-living things thereof, and added to all this, the vast number of creations of modern science. There, outstretched before him, all the accumulated knowledge and experience of the human race gained by a snail-like process down through the long period of human advance. He fails to perceive any scheme of unity or inter-relation in this vast galaxy of things. Yet he is in it and of it and his true happiness demands that he must function harmoniously as a part of it all.

We pictured him in action. In the course of his normal activities of play and work he encounters many perplexing and problematic situations. He finds himself in conflict with his environment wherein he should be in happy accord with it. The materials of his experience are objective in nature. His problems grow out of his contacts with these objective things encountered in the course of his activities in and about his limited environment. He manipulates, he observes, he turns to his elders and asks questions. Through these efforts he is achieving a satisfaction of his wonder about many things of the world about him.

As he matures his empirical thinking gradually gives way to reflective processes, when he begins to discern similarities and to note differences. He will begin to associate the familiar with the unfamiliar and will classify many of the formerly disjointed and unrelated elements and to a limited degree he will have satisfied his undefined longing for unity and harmony in the things about him. And he will have achieved a degree of control over them. From all this will come a corresponding measure of happiness.

It is obvious however that even in the most enterprising youth, the concepts and perceptions thus gained either by his

empirical method or by the untrained guidance of his elders will be inaccurate and crude. The meanings will be vague and at best progress will be slow and inefficient.

This picture of the child striving to orientate himself in a strange and unexplored world furnished a conception of the task before us. It became our task then to organize the great mass of facts, phenomena and things that constitute the physical environment in such a way that the child's activities could be directed through them by the most efficient and direct route to definite goals of understanding of this strange world of his to a fuller appreciation of its meaning, to a greater sense of harmony with its elements and a more intelligent and efficient use of the things that science has created for his service.

Now after the picture how could it be done? How could this great galaxy of things be graded and organized in such a way that the accumulated experiences of the child as he progressed from grade to grade would be enriched and would lead most directly to the desired goals. What should constitute the basis of organization?

The committee was conscious of a number of different ways the task might be accomplished. Some favored a simple seasonal treatment, developing the study units and activities according to the available material to be found in nature at the particular season. There was much to be said for such an arrangement. Seasonal changes and seasonal events are most regularly met by vital responses both mental and emotional on the part of the normal child. With a minimum amount of motivating influence exercised by the teacher these responses and reactions may be greatly intensified. By way of illustration — There is no denying that any systematic study of snow should accompany the thrill that comes to every child with the first snowfall. If seeds and fruits are to be studied there could not be a more opportune time than that season of the year when the child returns from his walk in the woods or fields with his clothing laden with clinging seeds. There never could be a more vital moment in the mind of the child for the study of rain than the first warm and refreshing shower in spring. Then too, the flowers and birds all come onto the stage, each one with its thrill, each one with

its challenge to the child's interest which in the hands of the skilful and sympathetic teacher, might easily prove another item in the enrichment of the child's life.

For the obvious reason then that some units can be taught effectively only at that season of the year when the phenomena are available much attention is paid to the seasonal arrangement in many parts of the monograph. It was decided however that such a procedure was inadequate if used alone.

Then came the suggestion of an environmental arrangement, to let the major aspects of the child's physical environment and the major activities of the child's life constitute the basis of organizing all the phenomena into meaningful units. By major environmental factors is meant those great factors that impress themselves upon the human mind, such as the sky, the earth, the air, water, living things, weather and climate, etc. By major activities is meant, use and control of the forms of energy, providing a food supply, providing shelter, protecting against disease, etc. Under each of these build up a body of phenomena and a series of activities that would lead to a comprehensive understanding of that particular factor of the child's physical existence as the ultimate objective of the eight years' study. It would be developed in a cycle or spiral form. No attempt would be made to exhaust any topic with a given grade. There would be included only those aspects of the topic in developing the grade unit, that would fall easily within the range of comprehension of that particular grade, leaving the more difficult aspects for treatment at subsequent grade levels. The same unit topic would occur in several or all the grades resulting in a gradually broadening perception and a fuller meaning as the child matured.

This method was advocated with vigor by some who clearly saw in it a fruitful approach to science and nature study. It was argued that mankind is a part of nature. He is in the midst of all the phenomena of nature. The sky, the earth, the air, the water, and all living things and lifeless things thereof are constantly forcing a challenge to his interest and wonder. Science started with the environmental phenomena, why shouldn't the child's learning start there?

But as an organizing element, environment was thought by some to be inadequate because of the exceeding complexity

of environment itself, and because of the difficulty to know just what phases were most profitable for inclusion, and which ones would be most profitable as points of departure.

The third method advocated was that of beginning with the end products of science, namely, the major scientific concepts as the specialist in the various fields of science have evolved and formulated them, for example, the great law of conservation of energy, the indestructibility of matter, the propagation of life from life, these merely illustrative examples coming respectively from the fields of Physics, Chemistry and Biology. Under each one of the great concepts of science build up a body of phenomena and a series of activities that would lead ultimately to a vital understanding of these concepts as objectives, in the hope that they would serve the student as intellectual tools to be used in the interpretation and understanding of this world and to furnish a method for the solution of the problems of daily life. It was argued that in spite of all the science training of today, the great masses of people passing through the schools are non-scientific in their attitude toward the problems of life. That science knowledge and habits and attitudes toward science and nature are matters of gradual development in humans — and that therefore even in the elementary work the subject matter should be of such selection and so organized as to lead most directly toward a mastery of the great concepts, and to direct the child toward the problem-solving attitude of mind.

There was strong objection registered against this method for the elementary levels. It was thought that it would be an attempt to formalize it and to remove it from the child's experience and therefore defeat the very object for which elementary science training was conceived. Major concepts are intellectual abstractions for any but the matured mind and relate to a specialized category. For the elementary levels, it was feared that any attempt to organize the subject matter too exclusively under the concept plan would tend to rob the science units of their vital significance to the learner.

So with all these points of view advanced with good arguments for them all, the committee was, to use the language of an authority who wrote me at the time, in the position of the other poor "worm" who could not make progress because

of his reflection regarding which of his many legs he should use first.

The plan finally agreed upon was that of a happy compromise which it is felt combines most of the favorable features of all these points of view. The committee came to realize that most of the arguments advanced were teaching arguments and not curriculum arguments. That what we were trying to prepare was a teachers' guide book and not a students' text book. With these conclusions the problem began to clarify itself.

Adult members of society, especially those who have become specialists in the field, tend to make a classification of their observations about nature for the most part into four great categories: Astronomy, Biology, Geology and the Chemical-Physical. These were adopted as fields of organization purely as a matter of convenience. At the beginning there was set up a list of concepts which are peculiar to and necessary for the understanding of these fields. These concepts are not used as points of departure nor unit headings. They are placed in the work for the teacher to have constantly in mind as goals to be striven toward but perhaps not attained completely in the elementary levels. In order to keep them constantly before the thinking of the teacher, there is associated with each item of knowledge and each activity throughout the work reference numbers indicating the concept or concepts toward which that particular item will contribute some understanding. This retains the value of the concept plan as a means of gradually directing the mind of the learner toward significant goals of understanding and of scientific thinking and still need not destroy the vitalizing and enriching value of the environmental science contacts.

In the actual get-up of the work much the same pattern is used for each of the eight grades. There are four parts to each. The first part of each grade development is a statement of Goals of Achievement in which is set down definite Knowledges, Abilities, Habits, Skills and Attitudes it is hoped to attain in the course of the grade work.

The second part is the subject matter and activity analysis. In this the subject matter in topical form is arranged in a tabulated sheet. Here activities and subject matter are sug-

gested under each of the five categories with the season indicated and also the concepts relating thereto. It is a chart of the whole field for that grade from which the teacher may make out a plan of work for any period of time.

Then the fourth part is the method and procedure. This part develops the topics into a real teaching and learning set-up. This is the part that brings the whole thing down to the class room. Here each study unit found in the chart analysis will be found developed first with a number of ideas or minor concepts to serve as immediate outcomes of the study unit and followed with a series of activities and specific readings. These activities and readings are designed to lead specifically to an understanding of the immediate minor concepts of the lesson unit.

With this set up, it is hoped that as the pupil advances and gathers an ever-broadening body of sense perceptions and minor ideas, these will build gradually into the major conceptions themselves. And through the activities involved it is also hoped that the attributes set as goals of achievement will be attained.

SCIENCE IN DOANE SCHOOL, CLEVELAND

Since the article following on page 608 was in type, the May, 1930, testing program has been carried out. The variation from the norm in Arithmetic Computation is as follows:

	6A	6B	5A	5B	4A	4B
1929	+ 9.5	+ 8	—2.7	+0.3	— 1.1	0
1930	+10	+11.7	+7	+4.6	19	16.2
					+19	+ 16.2

See page 615.

The Doan School Science Curriculum Center[1]

HELEN K. BRETT
Doan School, Cleveland, Ohio

Experimentation is a costly proceeding. It involves the expenditure of time, of money, of energy. Yet it is necessary for it lifts one out of routine. It implies temporary failures and successes — discouragement, often despair, but can only ultimately succeed when one is persistent in spite of obstacles, when one is willing to try not seven times but "seventy times seven" if need be.

To experiment in education is a particularly difficult thing to do for education is conservative and the glamour of the "good old days of the three R's" envelops the opinions of the patrons of our schools today and there is a tendency for the general public to sympathize with the comic strip which claims that "nothing is left of the three R's in the modern school but Rah! Rah! Rah!"

For the purpose of eliminating some of the difficulties pertaining to experimentation the administrative board of Cleveland two years ago set aside eight schools to be used for this purpose and to be known as Curriculum Centers. This past semester two more new schools were added to this number.

Each school was to be free to experiment in one subject or in two or more allied subjects only.

Those schools were chosen which had the least turnover, which had a central location and therefore were easily accessible for visiting, and in which the type of pupil was promising. In most instances the principal stayed with the school though in some cases changes were made.

Doan School, one of the older buildings of the city, easily accessible to Museums, brook, parks, the downtown office and the School of Education of Western Reserve University, was selected as the Science Curriculum Center. This school had not specialized in science work previous to this choice and only one of its teachers had been teaching science to her own pupils and had had a good background of science information. About

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1 Presented at the Elementary Science Section of National Education Association, Atlantic City, February 22, 1930.

a third of the teaching corps was retained and to complete the number — good all-round teachers from other schools who had done some science teaching, or who were interested in science and were willing to learn and to spend the extra time and energy which experimenting demands were transferred to Doan School. The effect of the work upon them will be discussed later.

Heretofore the building had had a reputation for good work of the more formal type. The principal had stressed the work in reading and only one room as stated previously originally reflected science. The teachers had had little experience in the organization of concrete material. It required a great deal of readjustment to make that building say "science" in every room — to encourage the bringing in of pets — not to mention "snakes and toads and things as girls is afraid on" — and to know what to do with them when they came in. It meant a special kind of supervisory helpfulness to change the attitude of teachers, to supply them with needed materials to help them over the difficult places, to teach organization, to encourage the bringing in of much concrete material, to get the necessary books, to build up a science library and to educate the parents in the neighborhood to the necessary changes. All of these adjustments were ably carried on by our special supervisor, Miss Mary Melrose, and by my predecessor, Miss Florence Lowe.

It is the belief of most educators today that a continuous program of curriculum revision is necessary to meet the demands of a changing world. The curriculum must contain in itself the qualities of producing people who will intelligently meet the social problems of the day and thus insure progress. It must consist of a series of experiences which will make a wholly integrated person. Each of these experiences must be good in itself and have in it material to make each successive experience better. It must enable pupils to ask intelligent questions and to know better how to answer their own questions and know when these questions are intelligently answered. It must build up desired attitudes and ideals. It must not sacrifice best learning output to obtain uniformity, efficiency of subject matter or examination. It must take concomitant learning into consideration. It must provide that learning

shall take place in a natural setting. It must not allow examinations or tests to control it or fix the type of study or the type of teaching. The curriculum must provide for learning through social relationships; for the fostering of superior abilities with which some children are endowed so as to develop the power of leadership and to help those who possess such abilities to realize the responsibility of using them for the social group. "The curriculum must provide for enrichment of subject matter without sacrificing definiteness and thoroughness."

These are the great aims of all our modern education. You know them. Many of these statements are quoted directly from your own books.

For the backbone of our teaching of science in Doan School we are keeping uppermost in our own minds the following aims or objectives:

1. Create a feeling of interest and wonder in the world about us.
2. Encourage first-hand contact with nature.
3. Acquire new knowledge.
4. Ability to learn from materials.
5. Ability to use materials.
6. Ability to observe closely.
7. Ability to use books.
8. Attitude of open-mindedness.
9. Appreciation of nature's laws:
    (a) Adaptation to environment.
    (b) Confidence in the laws of cause and effect.
    (c) Appreciation of the interdependence of plants, animals, man.
10. Provision for the use of leisure time.
11. Freeing the mind from senseless superstitions.

We believe now that any visitor to Doan School would have little doubt in his mind that our major subject is science. A small pool in our lower hall is a never-failing source of interest to children and adults alike with its goldfish, brook minnows and varieties of turtles. Showcases full of exhibits furnished by our museums or supplied by the children themselves and bulletin boards displaying science material deepen the impression.

Every room bears its evidence with aquaria — terraria — cages for pets—mechanical toys—crude models made by children but models that really work — specimens of insects — leaves — flowers and plants — rocks and minerals, etc. In fact anything that will make the work concrete to the children is brought in and finds a legitimate place.

In the fall and spring when more of our attention is devoted to the biological sciences we have had in our building for varying lengths of time the following kinds of animal life: cat — dog—guinea pig — rabbit — rat — alligator — snake— bat — flying squirrels — woodchuck — toad — frog—crayfish — canary — pigeon — parrot — chickens — bees — earthworms — snails — turtles — many kinds of fish — of live insects — of water life — and bugs and beetles without number.

In most of the rooms one will find drawings made by the children and clay models when that medium of expression is suitable — for to draw and model acceptably one must observe closely. Many charts are made and pictures are used to supplement the study of the real subject.

Our children sketch freely while talking and most of their explanations are made with chalk or with the actual object.

Each room is well equipped with science books and these are much in evidence.

While some of the rooms are still quite formal — in the majority there is an atmosphere of freedom and of life and most visitors are conscious of the fine spirit of cooperation existing between teachers and pupils which is apt to come when both are getting first-hand information together.

One smaller classroom is fitted up with glass cupboards and showcases which contain our small but growing museum collections. These are available to all the pupils and teachers in the building at any time.

The Educational Museum of the Cleveland Public Schools supplies us weekly with pictures, lantern slides and stuffed specimens and has also loaned us a compound microscope for the use of the older pupils.

At any hour of the day one may see groups of budding "scientists" gathered around some specimens, observing, sketching, learning at first hand.

While we do not adhere to the Course of Study in Elementary Science which is used throughout the rest of the system, we do follow the curriculum in all other branches. As stated before we have freedom to experiment only in the field of science.

Our work has been based on what seems to be the natural interests of pupils and teachers together, either drawn imme-

diately from their environment, or on sane correlations with other subjects such as silkworm study with study of Japan, tulips with Holland, etc., or on the natural leading from one experience to another.

From an analysis of our work last year we found these interests to have invaded the fields set up by most courses of study in science, namely: Under the heading Animal Life our work organized itself into study of mammals, birds, fish, amphibia, reptiles, insects, other invertebrates; Under Plant Life — that of trees, cultivated plants, wild flowers, flowerless plants; Under Physical Science — that of earth, weather, sky, mechanics.

From a grade by grade analysis we find a steady progression with but little overlapping even with the same particular subject.

For example in the field of Insects —

In Kindergarten, the child learned to recognize the butterfly, its wings and beautiful color; to recognize a grasshopper as such.

Grade I—Grasshopper—appearance in general, habits of jumping—food for birds—harm to man when in large numbers.

Grade II—Grasshopper—eyes—legs—wings noted—also habits.
Caterpillars—getting ready for winter—cocoon.

Grade III—Grasshopper—An insect because
1. Three parts to body.
2. Three pairs of wings.
Protective coloring.
Legs adapted to environment.
Destructive.

Grade IV—Grasshopper—appearance—habits—feeding and jumping—adaptation to environment.
Dragonfly—appearance—observation of flying—food—home—usefulness to man.
Bee—queen bee and workers—observation of work in the hives—use to man and flowers.
Wasp (Mud Dauber)—observation of home—food.

Grade V—Cricket—home—food—habits—kinds.
Structure:
Six legs
Three parts to body
Compound and single eye
Wings
Skeleton on outside of body
Comparison with grasshopper
Household Insects—Pests because of life history and habits. Control and need of extermination of flies, mosquito, bedbug, fleas, cockroach, clothes moths, lice, etc.

Grade VI—Life Cycle:
Economic importance or menace.
Need of means of control when necessary.
Grasshoppers and cockroaches
Butterflies—monarch
swallow-tail
cabbage

Moths—gypsy
tussock
silkworm
Beetles—ladybug—potato bug
Bees and ants
Flies and mosquitoes.

To determine in some measure what actual facts were being retained by our pupils we asked them one day to write down as many science facts as they could remember in a period of from thirty to forty minutes. These were tabulated and results obtained were as follows:

In grade six, 84 children stated 958 facts collectively, but 323 separate facts were accurately stated.

In grade five, 80 children gave 1362 facts with 537 different facts stated. This group had studied more subjects and the facts were more simple ones and more simply stated.

In grade four, 66 children stated 486 facts with 198 different statements.

In grade three, 90 children wrote 351 facts with 161 differences.

The statements varied in simplicity from: "Insects have six legs" to "Some parts of the steam engine are: flywheel, eccentric, eccentric rod, eccentric strap, slide valve, boiler, valve seat, piston, piston rod, steam port, cylinder, crank, rocker shaft, connecting rod." This latter list was given by twelve of the six A pupils.

A questionnaire entitled, "Do you like to study science? Why?" revealed the fact that from the third to the sixth grade inclusive there were just six pupils who declared they did not like the subject.

Among reasons given by those liking the subject we find such interesting statements as these:

"Yes. Because it helps me to know different things about stars, birds, insects, electricity, levers. I might discover a new plant or star, or something that scientists do not know."
Bernard Wertheimer—6A

"Yes. You will know the names of things when you see them outside. Science is interesting. It gives lots of information. You will notice things more than you do when you don't know anything about them." Lucille Koslo—5A

"Yes. Because it is interesting to find out why things work, why they grow, what things are, and why they are so." Martin Azoff—6B

"Yes. I like science because it has so many interesting subjects. I would like to be a scientist." Robert Heinricks—4B

"Yes. Because it is interesting and amusing. I might find out something that scientists have not found out yet. I would like to find what insects are made up of." Raymond Gregg—6A

In order that we may know more accurately just what progress we are making all of the children in grades two A to six A were given the Stanford Achievement Test the first spring the experimental work was started then again a year later and we expect to retest in another month or two. The results in the Composite Scores are as follows:

1928	6A	6B	5A	5B	4A	4B	3A	3B	2A
Median	60	56.1	51.6	44.3	41.8	36.3	23.3	19.6	13.2
Norm	56	51.	45.	40.	34.	28.	21.	14.	7
Variation	4	5.1	6.6	4.3	7.8	8.3	2.3	5.6	6.2

1929	6A	6B	5A	5B	4A	4B	3A	3B	2A
Median	67.5	60.2	54.	50.	42.5	34.1	24.4	19.9	21.1
Norm	58.	53.	48.	42.	36.	30.	23.	17.	10.
Variation	9.5	7.2	6.	8.	6.5	4.1	1.4	2.9	11.1

In Nature Study and Science our gains were quite noticeable. The Scores are as follows:

1928	6A	6B	5A	5B	4A	4B
Median	47.2	45.5	42.1	25.	25.5	19.5
Norm	47	40	33	28	22	15
Variation	.2	5.5	9.1	—3	3.5	4.5

1929	6A	6B	5A	5B	4A	4B
Median	62.3	53.1	45.5	42.8	34.4	25.3
Norm	49	43	36	30	24	17
Variation	13.3	10.1	9.5	12.8	10.4	8.3

Our greatest gain was in our reading ability:

1928	6A	6B	5A	5B	4A	4B	3A	3B	2A
Median	167	163.5	159.5	139.3	131.2	114.	23.3	19.6	13.2
Norm	158	147	132	120	105	85	21	14	7
Variations	9	16.5	27.5	19.3	26.2	29.	2.3	5.6	6.2

1929	6A	6B	5A	5B	4A	4B	3A	3B	2A
Median	190	172	157.9	148.5	139	110	92	69.1	59.7
Norm	162	151	139	125	110	92	73	55	28
Variation	28	21	18.9	23.5	29	18	19	14.1	31.7

So far the results more than justify our work. Our showing in arithmetic computation and arithmetic reasoning however is not so good and has made it necessary for us to devote much more time to this subject this semester. We have done some individual analysis of the problem and are now doing remedial work in arithmetic with the help of worksheets fur-

nished us by our Arithmetic Curriculum Center. One of our free teachers is devoting almost her entire time to the subject of arithmetic and I am confident that by the next testing time we will be back to normal in that subject.[2]

Doan School is particularly fortunate in the possession of an unusual science library since a special fund for experimental purposes has enabled us to be supplied with many fine reference books. All the new books published in science are sent us for review and for a try-out with the children. We are sending in to headquarters our recommendations that certain books be added to the staff library and to approved lists.

We now have over five hundred different science books of from one to thirty copies each besides such books of encyclopedic character, as—Lincoln Library—Compton's Pictured Encyclopedia — Classroom Teacher — Book of Knowledge and World Book in our own school library.

We are endeavoring to differentiate between books scientific in character and those of a literary nature with a scientific flavor. We feel that the world of living things about us needs neither fairies nor animals dressed up in human clothes or emotions to make it interesting to all children.

The books are all card catalogued and are accessible to teachers and pupils at all times either in the individual classrooms or in our library room.

Other teachers and principals throughout the system are urged to examine the books in our library before ordering or purchasing those for their own schools. In this way considerable saving may be effected.

Our pupils are given a half-hour library period weekly where the emphasis is on reading for enjoyment and there we encourage the use of books in literature other than science.

We also have a magazine stand where children may browse through such magazines as National Geographic—Geographic News Bulletin—Your Garden Magazine—Popular Mechanics —Scientific American—Popular Science—Nature Magazine — Progressive Education — Current Science — The Science Classroom — Nature and Science Education Review, etc.

Even with the good facilities at our own command, some pupils have made it necessary that the Branch Library of the Cleveland Public Library in our neighborhood increase its

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2 See page 607 for results of May Test.

supply of science material for their use. However with the growing size of our own library and our increasing emphasis on other types of reading this semester the librarian informs us that they are now being able to release some of their science books to meet the growing needs in other branch libraries.

One of the contributions which will soon be available to all Cleveland teachers is that of the subject file.

From the units of work written up by our teachers and from reviews of new science books sent us by publishers as well as the older ones already in our science library we have compiled a subject file of over five hundred seventy subjects each containing anywhere from two to twenty-four references.

These have been selected at random and will give an idea of the value of the file.

ELECTRICITY

Abbott—Everyday Mysteries—Page 63.
 Mechanics of doorbell—use of electro-magnet in doorbell and telephone.

Nida—Science Readers for Silent Reading V.
 Sketch of Edison and his Inventions.—Pages 180-191.
 Franklin's Discoveries.—Pgs. 41-49.

Persing—Elementary Science by Grades, Bk. III.
 Friction; tricks—Pg. 149.

Rush and Winslow—The Science of Things About Us.
 Types; Uses—Pg. 165.

Hall—Homemade Toys.
 Induction coil; how to make a shocking machine—Pg. 124.

Parker—The Book of Electricity.
 Complete circuits; how to make electric questioner.—Pages 55-56.

Collins—Amateur Electrician Handbook—Entire book.
 Treats all phases of electricity.
 Experiments with static and current electricity—motors—spark coil.

Williams—How It Works—Pages 112-186.
 Electrical apparatus, 112; telegraph, 127; wireless, 137; telephone, 147; dynamos and electric motors, 159.

Keelor—Working with Electricity—Entire book.
 Lights, 1; bells and magnets, 24; telegraph, 45; telephone, 61.

Gordon—Prove It Yourself.
 Magnets, 36; kinds of electricity, 41; telegraph, 63; telephone, 65; dynamos and motors, 66.

Cummings—Nature Study for Higher Grammar Grades.
 Questions and experiments on—uses of electricity, 246; laws of electricity, 248; inventions, 251-255, of lamps, bells—telegraph. (Teacher's Reference.)

Downing—Our Physical World—Pages 199-249.
 Early knowledge of, 199-202; frictional electricity, 203-204; Franklin's experiment, 205; Galvani, 205; Volta, 206; Ampere's discoveries—galvanoscope. battery, electro-magnet, 207 on—Discussion of telegraph, telephone, batteries; meter—dry battery—electric motor—household appliances, 221-249; cause of current, 223-226; direct and alternating current, 242-245.

Shafer—Harper's Everyday Electricity—Entire Book.
Batteries—circuits—wiring—resistance — currents — making and using of familiar electrical apparatus.
Persing—Elementary Science by Grades, Book IV.
Franklin's experiment, 188.
McFee—Wonderful Story of Science.
Electric furnaces, 325-366; early discoveries; electric motor, 355-369; how electric power is measured, 356; generators, 356-358; batteries, 357; dynamos, 358; transformers, 359-361; electric light, 361-366; heat from, 366; electroplating, 372; welding, 367-369; use in automobiles, 376-378.

ANTS

Cheesman—Everyday Doings of Insects.
Intelligence of; army of; wood ants—141-148.
Sight, 100; stings, 131; colonies, 227-231.
Comstock—The Pet Book—286-291.
Observation; cage; colony; young; characteristics.
Craig—Nature Study for Boys and Girls, Book I—31 on.
Appearance; habits; classes in nest.
DuPuy—Our Insect Friends and Foes—122 on.
Flying ants; new colony; nursing the larvae; cocoons; workers; toilet; slave raids; ant cone; storage of food; pest and friend.
Eddy—Friends and Helpers—114.
Intelligence.
Patch—First Lessons in Nature Study—15.
Ant cows.
Payne—Elementary Science Reader, Book I—100.
Kinds of; wings.
Caldwell and Meier—Open Doors to Science—161-163.
Development of; kinds; nest.
Persing—Elementary Science by Grades, Book IV—8-19.
Black carpenter, 8; colonies, 9-10; queen, 11; worker, 12; larva, 14; pupa, 15; food, 16.
Comstock—Handbook of Nature Study—419-428.
Discusses homes, young, colony, marriage flight, slaves, ant battle, plant lice and ants, 419-422; field observation, 422; how to make Lubbock ant nest, 423; ant nest and what may be seen in it, 425; observations in an artificial nest, 428.

Needless to say this file must be a constantly growing one and should be of ever increasing value to the other schools of Cleveland.

What effect has the work in science had upon the teaching force? This is always a vital question.

As previously stated, the selection of the teachers was made to include the average all-round good teacher who was interested in science, who had the ability to free herself from routine following of a definite course of study, and who was willing to experiment and carry on all the extra work which a science curriculum school demands. Not all teachers can be happy with so many things around as we find necessary at Doan.

We feel that in the majority of cases the teaching quality

has markedly improved. Most of our teachers are developing a technique of handling materials and are ready to seize opportunities that come their way. They are a conscientious, hard-working, enthusiastic, young group — the "young" referring to spirit not years.

They are constantly studying and learning, for as one of them remarked the other day, "You have no idea how much I have to read just to answer one of their questions." Most of them are taking extension work in science and three of them have spent a summer in the Nature Guide School at Hudson, Ohio, of which Dr. Vinal of Cleveland is head.

The fact that teachers and pupils are learning together makes for a fine spirit of cooperation and probably has a great deal to do with the friendly feeling we hope all visitors are conscious of at Doan.

We find great differences in the method of teaching science at Doan; and this is valuable, too, for by making mistakes and learning from them we may have something worthwhile to offer in teaching methods. Some teachers are touching many subjects lightly. One in the sixth grade goes broadly and deeply into a subject, yet keeps within the bounds of children's interests and abilities.

Though so much emphasis is placed upon science, we must teach the other branches of the curriculum also, and this condition has forced our teachers to seek for newer or better methods of teaching in branches other than science. They are mindful that our greatest aim is a well-rounded child, and are constantly alert to find ways of helping the individual child in his particular weak spot.

The curriculum centers are particularly fortunate in having two teachers assigned to them without pupils, but who are to free the regular teachers for a period a day, so that some of the extra work may get done. At Doan, part of the work of these extra teachers has been that of helping the slow or unfortunate pupil.

Our teachers, and some of our pupils, keep daily diaries of the science work. These include the questions asked by the pupils and the step-by-step progress of the work. The units as a whole are written up and contain also the bibliography and subject tests given by the teacher. We are making work-

sheets, which we try out in various rooms and which will some time in the future be ready for distribution to other schools.

What has been the effect upon the pupils?

Doan School has a student body of good average ability for a school in a large city. The turnover is slightly increasing at present and equals about twenty percent. Of the six hundred and more pupils about one-third are so-called American Gentile children and another third Jewish children, both of these groups from homes of good social standing. The other third is a very mixed group of some fifteen or more nationalities — including Lithuanian, Polish, Swedish, Italian, British, Swiss, Syrian, Negro, etc.

They vary in intelligence from 70 to 140 I.Q. About four percent of the school are enrolled in the Major Work Class for H.I.Q. and another four percent in the Borderline class for I.Q's from 70 to 85.

The interest in and enthusiasm for the study of elementary science is quite outstanding in most of the rooms. The big problem we face, of course, is that of guidance of these enthusiasms.

Our children have much to talk about and we never lack material for oral composition. Through command of subject matter they have acquired poise and fluency of expression and a noticeable lack of self-consciousness. Many of them are able to talk at length and in spite of interruptions, as some who have visited Doan School will remember. They talk with materials and sketch at the blackboard quite freely to illustrate their points. They are acquiring the ability to experiment and to persist in spite of difficulties and discouragements. They are learning to express their ideas through other media than words, as their drawings and clay models of animals from real life will testify. They are gaining a worthwhile knowledge of books, and a skill in using them. They like to quote their authority and compare one author with another. Their interests are quite genuine and carry over from grade to grade and from one semester to another. They are constantly on the lookout for things new and strange to them, and as one newcomer in the neighborhood stated: "Not a bug or caterpillar in the neighborhood is safe from the children. They are looking under fences and eaves and climbing trees with stepladders to find them."

On the whole they are a happy, interested and well-behaved group of children. The problem of special discipline is a very small one at Doan.

Contented children reflect contented parents in the home and we have been fortunate in hearing appreciative remarks from parents. One father tells us that "Billy is a better pal since he has studied so much science, for now we have much in common." Another said, "I'm glad Richard is learning to think things through clearly." Another tells us how much her tiny daughter has taught her about the trees in Doan school yard.

What of the future?

The experiences we are having at Doan School are worthwhile in themselves and will, we believe, lead on to still more worthwhile experiences. Our greatest weakness is possibly the need of more scientific background for our teachers. At the rate of two courses in biology or general science per year, this must necessarily be of slow growth. We have need of much wisdom in knowing how deeply to go into a subject with any particular group; in knowing how to guide the children's enthusiasms; in distinguishing between what is of passing interest to some particular child only, and what is sufficiently interesting to be worthy of class consideration; in being conscious of the dangers of wrong conclusions, or of conclusions based on too few experiments.

We need a school garden, where we may learn all the fine things that go with good gardening. Since there is no land available for a garden in the immediate vicinity of Doan School, this is one of the problems we have not yet solved.

We need association with the Boy Scout and Girl Scout movements. We expect to have a troop of the latter at Doan School this spring, if present plans mature.

We need largeness of vision. We need to realize as Jackman says — that "the child comes to the teacher with his eyes filled with a thousand pictures, but these are too often ignored and he is robbed of them one by one, until the beauty of this world fades from his sight and it is changed to a vale of tears."

We need to remember with Huxley that "to learn what is true in order to do what is right is the summing up of the whole duty of man for all who are not able to satisfy their mental hunger with the east wind of authority."

A Study of Indoctrination in Science Teaching *

Benjamin C. Gruenberg
Educational Editor, The Viking Press, Inc.

Science, as knowledge applicable to the manipulation of materials and forces, is highly prized by all and needs no further promotion. Those engaged in teaching often make the distinction between the transmission of such knowledge to students, and the cultivation in students of those attitudes and mental processes that are assumed to be characteristic of scientific thought. They assume the value of the latter to be vastly greater than that of the former, if only because the useable knowledge is constantly being superseded, whereas the methods of science are of universal and permanent validity.

Accepting the distinction, we may inquire how effectively science teaching does actually establish the attitudes and methods in question. How objective are students of science, not to say teachers of science, compared to men and women who have not been exposed to the process? How consistently do such students insist upon facts before forming judgments? How completely do such students succeed in liberating themselves from traditional postulates that are without warrant in established facts? How clearly do such students differentiate what they know from what they assume as practical expedience? Specialists in various branches of science, when confronted with the need of forming practical decisions in fields outside their respective specialties, may be daily observed committing precisely the same blunders of judgment, resorting to the same prejudices as serve the unscientific, and just as unconscious of the presuppositions and implication of their thinking. The claims of science to a superior method of dealing with problems has been, in recent years, increasingly challenged, ridiculed, and discredited. It may well be that our claims are rather high, that we have attempted to apply a good method where it does not fit. If so, we shall have to revise our claims. We may well consider, however, whether some part, at least, of the weakness is not due to defects in the teaching of science.

For the present study there have been assembled 500 extracts

* Read before Section Q. American Association for the Advancement of Science, Des Moines, Iowa, Dec. 28, 1929.

from 20 text books in Biology and General Science, intended for high schools, from several miscellaneous articles in scientific journals, and from scientific articles in general periodicals.† The writers are in all cases teachers of science. These extracts represent attitudes and thought forms which are in direct conflict with certain characteristics of scientfic method. Those submitted here are presented as indoctrination because they

(a) express basic assumptions for which there is no scientific warrant; or

(b) attempt to teach various conclusions or inferences, various postulates, and various explanations as established doctrines of the same order as "facts."

Personification of Nature

As examples of unwarranted assumptions are numerous passages that speak of the purposes of nature, or of various structures and processes; and others in which nature or specific materials or objects are personified.

The personification of nature is legitimate enough and often makes possible more picturesque or more effective presentation of observed facts. There is danger, however, in science teaching of resorting to nature as "explanation." Thus one writer:

> A simple coat of hair could not prevent him from being torn to pieces when he crouched under the attack of a larger foe, so Mother Nature gradually stiffened and lengthened his hair to pointed quills. For the quill of a porcupine is really a specialized hair growth that is developed as a need of protection and safety.

From science text books we discover that nature is foresighted, although the writers do not say that nature is another name for Providence:

> If the air were pure oxygen, fires could not be controlled and things would oxidize too rapidly. Thus another important use of nitrogen is to restrain the activity of oxygen and make the atmosphere suitable for life.

> Kittens are born and grow to be cats, and the plant bears seeds which will produce other plants like itself. By this wonderful provision of nature, although all organic things die, others like them are left to take their places. The processes of reproduction and nutrition are the two most important characteristics of all living things.

Nature is conscious and makes plans:

> The rest of the embryo follows by various ingenious schemes, all apparently planned by Nature to enable the seedling to escape uninjured from the testa, on whose protection it has so long depended.
>
> Each sense organ is especially designed to receive a certain kind of stimulus.

† These figures have no significance from a statistical point of view.

Nature is wise and we can do no better than follow her suggestions:

Darwin reasoned that if nature seized upon favorable variants, then man by selecting the variations he wanted, could form new varieties of plants and animals much more quickly than nature.

Yet Darwin himself knew that he was speaking in metaphors.

Nature is ingenious, as Romanes long ago pointed out (perhaps ironically), and can make one device serve a multitude of purposes:

From the delicious juices that flavor the peach and sweeten in the heart of the sugar-cane, to the bitter milk that flows in the dandelion or lures the unwary to death in the poisonous mushroom, all consist largely of water, absorbed from the soil by the action of the roots.

Nature is kind and finds compensation for the handicapped:

Insects can distinguish differences in color at some distances; they can see moving objects, but they do not seem to be able to make out form well. *To make up for this*, they appear to have an extremely well-developed sense of smell.

There is a very definite compensation (payment), however, for any plant or animal that has many enemies. . . . *Nature expects* that most of the young will be killed before maturity, but because of the great number, a few will survive. Numbers in the lower animals take the place of protection.

Nature plays favorites, which is all too human:

Such plants—the dandelion, butter-and-eggs, the shepherd's purse—are particularly well *fitted* by nature to produce many of their kind, and by *this means drive out other plants which cannot do this so well.*

Nature shows human qualities further in being, on occasion, whimsical:

Frequently the petals or corolla have *bright marks or dots which lead down* to the base of the cup of the flower, where a sweet fluid called nectar is made and secreted.

To this should be added, however, that frequently the petals or corolla have bright dots and marks which do not lead to anything; and sometimes flowers without such marks are also visited by insects.

Most human of all, perhaps, is the teaching that nature sometimes makes mistake:

To be truthful, we must admit that the efficiency of the paralyzing stroke which Mrs. Solitary deals her victims is not always perfect. Sometimes the blow kills immediately. Sometimes the prey recovers completely within a few days, and then the poor infant Solitary is born face to face with an awful ogre.

Science is wonderful and can discover nature's secrets; or, if we are to be more modest, we may say that nature does not hide her secrets too closely, for even fourteen and fifteen-year old children can find them out:

Which does Nature consider the more important, the life of an individual or the life of a species? Find proofs in this chapter.

Teleology, Conscious and Unconscious

"Purpose" is frequently assumed, not as a deliberately selected philosophical postulate, but as a naive, uncritical animism; and appears in casual forms of expression that take it for granted, as one takes for granted the endless alternating of night and day:

. . . husks are developed *to protect* the corn ear.

. . . mineral matter . . . is absorbed by the plant *to be changed* by it into its food.

. . . protoplasm . . . a mixture of several compounds that are organized *to carry* on the life processes.

Then the blood supply is automatically increased *to bring* extra white corpuscles on guard *to oppose* infection.

The pistils . . . are often feathery or hairy *to enable* them more easily to catch the pollen.

. . . insects that are believed to be unpleasant to taste and have bright colors on their bodies *to warn* the animals that prey on them that they are unsuitable as food.

In cases where the food is stored outside the embryo, as the endosperm, the cotyledon often remains in contact with it *to digest and transfer* food from endosperm to embryo, as is the case in corn.

. . . mouth parts are *for biting*.

Cotyledon . . . has ferments *for digestion*.

. . . the pistil *for catching pollen*.

Fur-bearing animals possess mammary glands *for nursing* their young.

. . . the grasshopper . . . has air tubes *for breathing*.

. . . an upper lip . . . and a lower lip . . . *for moving the food* into the mouth, . . . a pair of mandibles *for cutting food*, . . . maxillae with palps *for carrying* the food.

All living things are composed of matter and liberate energy . . . *for the maintenance* of their life activities.

. . . The monarch frequents the milkweed *in order* to lay eggs there.

In order that roots may always grow where they can best absorb . . .

More explicit is the assumption of purpose in the following examples:

The earthworm . . . has done the thing best *designed* to protect its simple body.

. . . a species of wasp, that . . . places its eggs in the holes with paralyzed caterpillars *designed* as food for the babies.

Even the behavior of the dog that shakes the rain off its coat, and of the bird that water-proofs its feathers from the oil-glands at the base of its tail, is *designed* as a protection.

Digestion has the same *purpose* in plants and animals.

State the main *purpose* of respiration in all living things.

. . . plants do not breathe as actively as animals, still it is thus proved that they do breathe in the same way and for the same *purpose*, namely, to liberate energy for life.

. . . soil roots also for the *purpose* of absorption.

For the *purpose* of absorbing as much as possible, the surface of the active parts of all roots is covered with root hairs.

Describe the appearance and *purpose* of the root hairs.

One *purpose* of roots is to anchor the plant firmly to the ground.

Canals, *for flow* of water upward; sieve tubes, *for flow* of sap downward; tough 'bast' fibers, *for strength;* the thick, dead bark, *for protection.*

What seems to be the *purpose* of the bark?

Fruits and their *purpose.*

What is the *purpose* of buds?

. . . the *purposes* of neurones? of a nerve? of a ganglion?

. . . the *purpose* of automatic reflex movement.

. . . coal and water are as necessary for the development of heat and power in the engine, as food and water are for a similar *purpose* in the horse.

. . . All reflex movements of this type have a *purpose,* usually to protect the body from injury.

. . . the one cotyledon of the corn grain does not serve the *same purpose* to the young plant as do the two cotyledons of the bean.

How flowers are adapted to their *purpose.*

The chief *purpose* of a flower is reproduction.

. . . the *purpose* of stamens and pistil?

. . . and the petals are adaptations *for the purpose* of attracting insects to distribute pollen.

. . . the earthworm's ovaries . . . may be considered as similar in *purpose* to the ovaries of a flower.

. . . the adaptations of the bee for *various purposes* . . . the pollen basket, an adaptation *to aid* in carrying pollen; . . . a pair of shear jaws, an adaptation *for cutting* wax to use in cell building.

The mouth of the bee . . . is used for the *purposes* for which man would use the hands and fingers.

. . . secretions (of plants) however . . . often serve the *purpose* of preventing animals from eating the plants.

"Function" is of course commonly intended when the word "purpose" is used, as in this one of many similar examples:

What are the differences in function (purpose) between the sensory and the motor nerves?

It is evident, however, that the identification is uncritical.

Naive Animism

The personification of the objects of nature shows itself commonly in the kinds of verb used:

The potential energy is there and *is only waiting* for the necessary forces or conditions to release it.

The periodic relations of atom nuclei show that special types of composition with respect to evenness and oddness of number *are very much preferred* to others, and that evenness of number is much more common.

For a considerably longer period of time, however, the impulse is in the brain, *trying to find* which path it must take. . . .

Roots *search* for water.

Roots *hunt* out . . . especially for the purpose of taking up water.

The roots will start downward at first, directed by gravitation, but when they have penetrated the sieve, they will turn toward it again and re-enter the moss *in order to find moisture.*

. . . the root hair, because of its protoplasmic lining, *selects* what will be absorbed, while the apparatus does not.

Why does a leaf *seek* sunlight?

The methods of *seeking protection* are various, but they all tend to accomplish the same object, which is the preservation of the individual and the race.

Most plants and animals *stand in an attitude* of mutual helpfulness to one another, plants providing food and shelter for animals; animals giving off waste materials useful to plants in the making of food.

As the plants grow, there *is a further effort* to gain the greatest possible exposure to sunlight and air, and in case the fruit matures, *to secure* as wide a dispersal of the seeds as possible, *in order that* the continuation of the race as well as the growth of the individuals may be assured.

It is generally accepted by the scientific world that self-pollination is harmful to the species. Most flowers apparently *conform to this view* and employ at least two well-defined methods for preventing it.

Instinctively the things (parasites) *avoid killing* their sources of food.

Some of these are no worse than the classic teaching that water seeks its level. In other cases the personification appears as assertion of desire, preference, or even of reasoning:

There are insects that *like* to feed upon the apple leaf.

In case the family *wishes to* produce a queen, the workers construct a much larger cell by removing the walls of two or three adjacent cells.

Foods *preferred* by bacteria.

Other fungi (and we will find this applies to some animals as well) *prefer* living plants or animals for their food.

Some flowers, like skunk's cabbage and the carrion flowers, *attract flies by their unpleasant odor.*

Red clover is another illustration. Its *favorite* insect is the bumble bee and its parts are well adapted to receive this visitor.

Variety, then, in all kinds of foods is what the body *is craving.*

These hatch into little worm-like creatures, which *so irritate the leaf that it grows* a little house around them to shut them in.

. . . insects *evidently* have a *reason* for doing this.. . . To find out why they go there and what they do when there, it will be first necessary for us to study flowers with the idea of finding out what the insects get from them, and what the flowers get from the insects.

The confusion between purpose on the one hand, and function, behavior, or adaptation on the other, carries over to the world as a whole. Thus, there is a discussion of the importance of bacteria, which includes the benefit to the soil, in the formation of humus; and another of the forest, which is similarly headed "Benefit to the Soil":

Furthermore, the organic matter (humus) which collects on the forest floor, supplies an essential element to all fertile soils.

When purpose becomes rampant it may well clamber over the hills and the everlasting rocks.

In a dense forest or in a narrow valley, the trees are tall and slender; in less crowded places, shorter trunks serve the purpose.

What Is an Experiment?

Doctrinaire teaching is indicated by confusion regarding the meaning of the *experiment.* Many authors consistently introduce experiments with instructions *to assemble* specified materials and *to do* something with them. The operation itself is in most cases followed by the drawing of inferences: "What does that show?" But not always. There is an "experiment" in which the relation of light to photosynthesis is to be learned by covering a leaf with dark paper or cloth for a day, and then testing it for starch. There is nothing said about the parallel behavior of exposed leaves, but there is a suggestion that is interesting:

Repeat the experiment with a photographic film fastened on the leaf. Sometimes good "leaf prints" can be obtained.

Again and again Experiment means the manipulation of materials:

If the experiment has been successful, only jar B will show bubbles.

The setting up of controls and the question of negative instances are often disregarded:

Place a little iodine upon some of the cornstarch. Note the reaction. The blue-black color is a sure test for starch.

Two solutions are used in the Fehling test, one colorless and one blue. When these are added in equal amounts to a similar amount of the substance to be tested, and the mixture heated, a yellow-brown solid will form if grape sugar be present. Cane or beet sugar will not act this way.

These are from two different books. Nothing is said in either about other categories reacting similarly with the reagent.

There are frequent uses of statistics to illustrate a point, but in the books examined there is no critical consideration of possible alternative interpretations of the facts, to say nothing of a critical evaluation of the figures as given. The statistical references in these books are chiefly to the practical questions of alcohol, tobacco, public health measures and the economics of agricultural applications of biological facts and principles.

We Are All Evolutionists

The doctrinaire attitude is especially striking in the casual transmission of ideas about evolution and of other biological problems:

In that year Charles Darwin, an English scientist, published his "Origin of Species by Natural Selection," and established the theory of evolution on a firm basis. This theory is the corner-stone of all recent science and the foundation of all modern thought.

The time was not ripe for acceptance of Lamarck's ideas; moreover his theory was not in accordance with facts and was forgotten for fifty years.

Further evolution (of plants) hindered by lack of sensation and motion.

Animals and plants tend to vary each from its nearest relative in all details of structure. The strong may thus hand down to their offspring the characteristics which make them the winners.

This may be described as an acquired immunity that is transmitted by heredity from one generation of grapes to another (i. e., grafting European vines on American stocks).

The porcupine's ancestors were night animals. It was natural, therefore, for him to sleep during the day and forage at night.

Now, if a hawk should fly over some day when a tabby cat was out with her kittens, you would hardly expect to see her covering them as a hen would cover her chicks. Because, you say, a cat isn't born that way.. Because the cat's ancestors have been doing other things through the ages, and the cat has inherited its ancestors' ways of behaving just as surely as it has inherited its whiskers and its tail.

Many human pedigrees clearly indicate that such qualities as musical ability, literary aptitude . . . and various moral and immoral traits are inherited.

The foundation substance is called protoplasm. . . . It is well named, for it is the first and most necessary substance of all organic things.

The little seed that we began with is now a well-developed plant. It has all the parts that a small plant needs.

What advantage to an animal is the possession of organs? Are organs ever a disadvantage?

. . . for since there is no endosperm in the bean, the plantlet must seek its own nourishment very early.

The animals of the forest, field and stream choose their food by instinct; they will not eat anything to which their digestive systems are not adapted.

Starch is insoluble in cold water, and does not pass readily through the absorbing membranes. *Therefore* it has to be digested (changed to soluble sugars) before the plant can use it.

The body heat of warm-blooded animals keeps their fat always fluid, but the plants, having no source of heat within themselves, *necessarily* produce only liquid fats like olive or cottonseed oil.

Just how these organisms (anaërobic bacteria) get the oxygen necessary to oxidize their food is not well understood.

The material left behind after the bacteria have finished their meal . . . has a characteristic "rotten" odor, and it has in it poisons which come as a result of the work of the bacteria.

The trunk of the elephant is another unique adaptation. It is really the nostrils and upper lip greatly drawn out, and is used in browsing and in drinking, *because* the elephant's large bulk and short neck prevent him from reaching down to graze or to drink.

The grasshopper has little difficulty in finding it food. It eats leaves, and particularly the blades of grass. *It does not need* a keen sense of smell, as does the bee, which must search for flowers.

In addition they must reproduce *in order that* the race may not die out.

Within this is the nucleus of the ovule cell which divides into eight cells, two of which form the endosperm and one, *the most important*, becomes the egg or female cell.

Air is everywhere around us: light is *necessary* to us, *so much so* that we use artificial light at night.

All leaves *must* receive sunlight.

What *necessity* is responsible for the arrangement of leaves on plants?

The root hairs, if developed here, would be torn off as growth proceeded, *hence* begin to grow further back from the tip.

From the foregoing it is evident that roots *must be* profoundly varied in structure and form *to perform* the different functions mentioned.

Osmosis in roots is affected by the temperature and amount of moisture in the soil, being less in cold, dry seasons. Also the presence of organic acids in bogs, or of certain mineral matters in some soils, tends to hinder or prevent the process. *Hence it follows* that in our cold season, most plants shed their leaves, *so that* they have less surface from which to evaporate water, *because* their supply is cut down by the cold.

If the grasshopper fails in any one of the first three of these it is unable to live, and *consequently* the last and *most important work*, that of providing for the next generation, is not possible.

While young salmon react positively to heat, and in consequence migrate to the warmer waters of the ocean, older salmon become negative in their *responses* and migrate back to the colder waters of the mountain streams.

Before the bodies of animals and plants grow old, preparation *is always* made to produce more animals and plants like them. This has been the story since the beginning of life, so far as science can determine; *and it is the only means* by which there can be any increase in the total number of living things.

We have seen that the chief *reason for* flowers, from the plant's standpoint, is to produce fruits which contain seeds.

Give a logical explanation *why* certain plants produce such enormous quantities of seeds. What would happen if all of them were to take root and grow?

Which plants, as a rule, have the more seeds, weeds or cultivated plants? Why?

This is an important method of reproduction in the life of goldenrod plants and *causes* them to grow together in patches.

The *secret* of their great success in spreading is in part due to their ability to collect pollen in large quantity by means of the clustered arrangement of their flowers.

What is the reason for this difference? (Sexual plumage.)

The more intelligent animals have learned ways of sheltering their

young from danger; *consequently* they need few offspring to continue their species (kinds) . . . *for this reason* they are obliged to give them the greatest protection until they are strong enough and wise enough to take care of themselves.

Explain fully the *reasons* for this difference? (between animals that leave parental protection early and those that remain late.)

Such flowers may also lack odor, nectar and bright color. Can you tell why?

Accordingly they (flowers) have their parts so arranged as to admit only *favored* visitors. Its favorite visitor is the honey bee.

The nymph has a firm outer covering called an exoskeleton, which stretches but little with the growth of the nymph. *Accordingly*, at stated periods, the nymph sheds this exoskeleton, and grows until it fills is new exoskeleton.

The flower of "Lady Washington" geranium, in which stamens and pistil ripen at different times, *thus insuring* cross-pollination (!)

Beyond Science

Moralistic, philosophical and social theories are often drawn into the argument either for the deliberate purpose of influencing attitudes, or unconsciously as assumptions uncritically accepted. There is here a difficult problem in higher education, for most of us, as teachers, seem unable to differentiate propaganda from the well-intentioned teaching of commonly accepted — but unchecked — "beliefs."

If your sympathies are democratic you will be glad to have prospective citizens taught what science teaches on that point:

Thus the decision as to whether the young bee shall be a queen or a worker rests with the workers themselves. They also have the power to supersede the queen, or to raise a new queen in case of the sudden death of the old one. These powers are *rightly* intrusted to the workers—*the great majority.*

However, you may not care to go as far as did the Bolsheviki; so note this:

We believe that nothing happens by haphazard chance. Success isn't an accident. Men's hopes and dreams are realized only after long hours of hard work. Revolutionary Russia hasn't got far, for it tried to secure wealth and leisure without working for them, and the millions who have consequently starved to death in that country bear testimony to the truth of the scientific conviction that we can't get something for nothing. As we sow, so shall we reap.

Science is thus well calculated to serve mankind, not only on the material plane, but on the highest reaches of spiritual aspiration. From one of our leading scientists we learn:

Science is making us better Christians.

Science is teaching men how to co-operate more intelligently with God: it is teaching men what His laws are and how to obey them.

Science is proving that the human soul is the greatest thing in the Universe, and the supreme purpose of the Creator. Science is leading us closer and closer to God.

It is perhaps unnecessary to repeat that one can be a first rate scientist and at the same time both ignorant and illogical in matters outside his specialty. This is not to disparage either science or scientists. It is, however, significant as an educational problem. The scientist, as scientist, has resented the authoritative posture of theologians and politicians pronouncing solemn nonsense on subjects they did not understand. It is not asking too much that teachers of science, as such, refrain from making solemn pronouncements upon subjects of which they can speak, if at all, as more or less opinionated laymen.

Even on educational topics, a teacher of science, by virtue of being a teacher, may be rather uninformed:

> It (biology) is inseparably linked with the agricultural, economic, civic, and religious progress of the country. . . . The educator is *better able to solve the problems of education* when he comes to know *that man is a rising animal and not a fallen angel.*
>
> Besides the *discipline* it (biology) gives me, is there anything that I can take away which will help me in my future life.
>
> Accurate observation is a very rare but valuable trait, and biology will greatly increase the powers of observation.
>
> Although it appears that good memories, like good health, are inherited, yet it is also true that an ordinary memory can be vastly improved by proper training, or a good one seriously damaged by neglect.

Enthusiasm for his subject on the part of the teacher is a valuable asset, educationally; but the more effective his teaching, the more danger is there in his dogmatism. We sometimes claim for our subjects more than we can substantiate:

> In the first place, there are few subjects that add so much to general culture by increasing the number of things in which we are interested and about which we should have information.
>
> Biology does not neglect the aesthetic nature of man. If the wild life of this country is to be preserved for the future generations to enjoy, it must be protected.
>
> Students of even such an elementary course of biology as this, possess the needed information to enable them to tell the difference between fakes and real remedies. This is one of the important results that you should obtain from this study.

Alas, even more advanced courses cannot guarantee results. Many a college graduate, many a Ph.D. even, is teaching, on the authority of science, that "energy, like matter, cannot be created or destroyed," when all we are sure about is, first, that within the limits of our instruments of precision, destructions of energy or matter *have not been positively demonstrated;* and second, for the purposes of clear thinking in physics and

chemistry we find it convenient to *assume* the conservation of energy and matter.

Finally, the concept of "law," which thoughtful scientists and philosophers have repeatedly attempted to liberate from the dominations of theology and political autocracy, remains with science teachers a mystery before which the pupil is made to bow and blink. Laws continue to "govern," and violations of law continue to incur penalties:

> The conditions in many of our cities, where tenement houses are packed with people as a vacant lot is filled with weeds, violates all the natural laws of proper living.
>
> On the other hand, science teaches us that everything in the world happens according to law.
>
> Nature presents a harmonious unity, governed by fixed laws, which by their interaction produce an infinite variety of results.
>
> Always note that Nature inevitably exacts her penalties.
>
> No one has made such successful application of these laws of inheritance as Luther Burbank.
>
> A number of theories have been advanced as to why these anarchistic tendencies (cancer growths) are manifested by cells which ordinarily live up to the natural laws.
>
> Man sees himself as part of a great system, governed by laws the operation of which are as dependable, if not as well known, as those of physics and chemistry.

Uniformitarianism must be assumed, for the purposes of science; and we construct or "discover" laws on the basis of observed uniformities. We may be sure that the underlying uniformities are constant, and so "dependable," perhaps; but in what sense are they "laws" before they are "discovered," and so known? One of the teachings of science is that "man's concept of truth is constantly changing," and yet the same teachers of science teach that nature's laws are invariable. If the latter is true, then a law, once found, should stay put, and so far as its domain is concerned, concepts of truth need not change. If the scientific concept of law is too difficult for the beginner to grasp, it would be better to leave the word entirely out of our elementary texts. If it is not beyond the capacity of the prospective teachers in college or training school, the idea needs more direct attention.

I submit that so far as science has anything to say on the subject, none of us today knows what is the purpose of nature or of any natural object, structure or process. If this use of teleological language is defended as being merely a manner of speech, then it is important for science teachers to decide whether, in the present stage of our knowledge, such speech

forms are warranted as being more clarifying than confusing to the student of science. When the poet speaks in metaphors and similes he is speaking in the only language available to him — or to the scientist. The scientist, however, seems to have forgotten in many cases what the poet always keeps clearly in mind, namely, that he is speaking in similes and metaphors. When the poet says, "My love is like a red, red rose" he does not make the mistake of forcing upon his readers or listeners the suggestion of a thorny trunk. When the science teacher says that the Kalima butterfly is like a dead, dead leaf, he often makes the mistake of forcing upon the reader the conclusion that the shrewd little butterfly chrysalis designed and perfected its distinctive adult garb in order to deceive the birds and the lizards; or at least that kind nature provided the coat in order to restrict the diet of birds and lizards to insects that she could better spare.

It is one thing to say that the geranium turns toward the window *as if* it loved the sunshine; it is quite a different thing to say that it turns toward the window *because* it needs the sunshine. It is one thing to teach that the water pump behaves *as if* nature abhors a vacuum; it is a different thing to teach *that* nature abhors a vacuum. No doubt some gain is made when we abandon the theology according to which Jehovah loves the Jews, but this gain is somewhat offset if we then adopt the "science" which teaches that Nature loves the Nordics.

The tendency to indoctrinate is not to be considered peculiar to teachers of science. It is in fact a traditional part of the methodology of the teacher. Or perhaps it is characteristic of homo when he adopts the role of teacher. We should nevertheless give some consideration to the phenomenon in order to assure ourselves that a program of education which undertakes to inculcate the scientific attitude is indeed practicable.

With the rise of science into popular favor as a subject worthy of school time and effort, during the middle of the last century, there arose also the conflict between the educational philosophy of the older disciplines and the supposed practicality of science. The humanities were of value in proportion as they were of no use, so to say; science was of no use, educationally, because it promised to be of value. The protagonists of science were confronted with well-entrenched

opponents who had a tradition of educational methods attested as of high potency. Science still had to establish itself as educationally worthy. What more natural than for the promoters of science to demonstrate the worth of their subjects, as education, by adopting the approved and accepted methods of the older subjects? And what more natural than the transformation of science teaching, for the time being, into a system of doctrine?

This is not submitted as an explanation of the dogmatism of science teachers, but as a hypothesis for further investigation. In this connection it would be well for all of us to gather data on the obverse phase: To what extent do we find cultured men and women, not specifically trained in the sciences, adopting what we like to think of as a scientific attitude, toward all problems? Is there any evidence of scientific skepticism and open-mindedness among students of politics and economics and history, comparable to the dogmatism occasionally found among students of physics, chemistry and biology?

It is undoubtedly true that the specialists engaged in research are able to maintain, with respect to their respective fields, all the virtues of the scientific method at a high level. It seems also to be true that human beings, whether research workers or not, tend to assume the dogmatic tone when they begin teaching. The only remedy for the situation would seem to be in some process that keeps the teacher, as teacher, constantly in the posture of learner, whether this is by means of formal research or otherwise. If this is sound, it has important bearings upon the organization and methodology of education, and upon the training of teachers.

Cartesian Divers

Sadie Cline Shiple
Franklin School, Toledo, Ohio

Every true science classroom should make room in its scheme for pupil construction of devices that will create a desire in each student to learn about things scientific and at the same time develop in him the ability to see clearly, to imagine vividly and to think independently.

I know of no other device that will arouse a group of students and hold their *continued* interest, as the cartesian diver does. To begin with very few children have ever heard of the device, therefore mystery lends enchantment and immediately instills in the student a certain degree of curiosity and curiosity is the mother of education.

When the class is told that a cartesian diver is a clever little arrangement of a little bottle filled partly with air and water, inside a larger bottle containing water which will dive to the bottom when you press on the cork and come up again when you release it, there will immediately be a contest on to see which student will be able to construct the first successful one. The next race will be to see which one can outdo the others in making the most unique one.

No activity should be carried on in any science classroom that does not teach some scientific truth or principle. We should therefore be sure that this activity makes clear that this device which was invented by Descartes the great French philosopher in the seventeenth century illustrates the principle of the transmission of pressure by liquids, the principle of Archimedes and the compressibility of gases. The student should discover that pressing on the cork pushes a little more water into the little bottle making it heavier and it sinks, releasing the cork causes the compressed air in the little bottle to force a little water out making it lighter and it rises. He should through this experience understand that a modern submarine is essentially nothing but a huge cartesian diver which is propelled above water by steam engines, and when submerged, by electrical motors driven by storage batteries. The volume of air in its chambers is changed by forcing water in or out and it dives by a combined use of the propeller and rudders.

The following list includes various ideas and results that we have from time to time worked out with our groups. We have used most any size and shape bottle from one to two inches tall to a gallon vinegar bottle for the container. For the diver we have used besides tiny bottles various celluloid dolls such as Santa Claus dolls, cupids, dolls made from carrots, clothespins, pencils, pen tops, test tubes, tin tubes

and even pieces of match sticks. In the case of the celluloid dolls a hole is made in the foot to allow the proper amount of air and water to enter. While in the clothespins, matches, etc., the pore spaces are filled with air which corresponds to the cavity in the doll or the bottle. We often add to their beauty by tinting the water various colors.

We are always able to get at least seventy-five per cent student participation.

Food and Health--A Socialized Study Period

Sadie Cline Shiple

Franklin Junior High, Toledo, Ohio

Editor's Note.—This playlet was written by Miss Shiple's class and presented to the Business and Professional Woman's Club as a part of a health program.

Characters—18 eighth-grade girls.

Time—Several study periods.

Place—Activity Room.

Act I

Girls chatting before study period.

Enter Jean.

Jean. Oh, girls, Mrs. Smith just gave me the questions for our new unit.

Girls. What's it about?

Jean. Food, I guess.

Girls. Food? That sounds good. Are they hard?

Jean. I don't know; judging from our past units they are always hard but very interesting. Don't you think so?

Girls. Yes! But don't keep us in suspense.

Jean. As usual, she did not tell us to do this or that but only made suggestions. This is what it says, "Do you know that all foods come from plants?"

Fern. That's one of her challenge questions. I don't believe it.

Dorothy Jane. Not so fast, Fern. I'll bet that question has a big purpose in our unit. Let's think of foods and then trace their origin.

Fern. All right! How about beefsteak?

Dorothy Jane. Well, the cow eats grass, so in the long run it really comes from plants.

Girls. What do you know about that?

Margaret. How about eggs? Can't trace that to plants very well.

Dorothy Jane. Yes, Margaret, the hen eats grain to make the egg.

Margaret. Right again, Dorothy Jane.

Elna. Well, try fish then?

Dorothy Jane. Again, the fish eats seaweed or water plants.

Girls. Well, Jean, I guess your first question is answered.

Jean. Write it down then, the source of all food is plants.

Elinore. Proceed! What is the next one?

Jean. "How do plants make food?"

Thelma. My, I'll bet it will take us a month to find that out, but I bet Lily could do it.

Jean. Will you, Lily?

Lily. Yes!

Jean. All right, we'll count on you. Here's the next one. "Do you know about the different kinds of food? C-a-r-b-o-h-y-d-r-a-t-e-s (*class pronounces*), fats, proteins, water, Vitamin A, B, C, D. Who'll take carbohydrates?

Mabel. I will, Jean.

Jean. All right, Mabel. Who'll take fats?

Elinore. I will.

Jean. All right, Elinore. Who'll take proteins?

Thelma. I'll take that one, Jean.

Jean. Fine, now who'll take water?

Fern. I will, Jeanny.

Jean. All right, Fern. Now who'll take vitamin A?

Dorothy. I will.

Jean. All right, vitamin B. Oh, well, I'll take that one. Who'll take vitamin C?

Lucille. I'll take that one.

Jean. All right. Vitamin D?

Josephine. I'll take that one.

Jean. Fine! Here's another one. "Do you know how many calories we need?"

Helen. Calories? I never heard of that word before but I'll try to find out about it or them, I don't know which it is.

Jean. Good, you always were a willing worker, but I am almost afraid to ask anyone to take the next one it sounds so terribly hard.

Margaret. Let's have it, I like shocks!

Jean. "How does food become a part of the body?"

Marie. Oh! I'd like to take that one. I have a picture about it.

Jean. I guess I'm the one that received the shock. Thank you, Marie, I'm glad you didn't say, "Jean you take that one."

Gertrude. This seems hard but I know we are going to like this unit.

Dorothy (*overweight, fat*). Well, who doesn't like food?

Girls. Not you, Dorothy, not you!

Jean. Do you know that our study period is up?

Ruth. It is? Are you sure your watch is right?

Ruby. Jean's watch is always correct, but listen, girls, let's make posters and do some outside reading. Sounds awfully interesting to me.

Jean. Yes, girls, you know the only way to get a plus on your A is by posters or outside reading.

Girls. (*Preparing to leave*) O. K., Jeanie! A word to the wise is sufficient!

ACT II

Girls seated in circle ready to display their posters and give their preparations.

Jean. (*Entering*) How did you get along with your assignments?

Lily. Just fine, I talked it over with my mother, she told me all about it. It was very interesting. Even the name of the process is a study in itself. Listen, P-h-o-t-o-s-y-n-t-h-e-s-i-s!

Girls. Photosynthesis? Tell us more about it.

Lily. I made the suggested poster and did the outside reading, too. My whole family became interested. Look at my little cupies! (*Displays poster of photosynthesis. The poster used was a green tree. The green part was covered with red cupies whose initials were CO_2. The roots were covered with orange cupies whose initials were H_2O.*) Photosynthesis is a chemical change which takes place in plants to produce our food. Only green plants are able to combine the elements of air and water and make food. This process is carried on in the leaves through the agency of sunlight. The air enters the mouth of the pores which are very numerous underneath the leaves. The working cells on the upper side of the leaf, contain tiny green bodies which are able to break up CO_2 into its elements (*carbon and oxygen*). The carbon combines with water to make sugar and starch, while the oxygen is given off as waste matter. The green cells of the plant act as food factories which are run by the powers of sunlight. Photo means light, synthesis means putting together. Summary:

1. Occurs only in plant cells containing clorophyll.
2. Operates only in the presence of sunlight.
3. Absorbs carbon dioxide.
4. Sets oxygen free.
5. Constructs carbohydrates.
6. Stores away light and heat energy in the form of potential energy.

Florence. What are those cupies?

Lily. They represent water and carbon dioxide.

Girls. Fine!

Mabel. Nothing on me, fair photosynthesis. I made two suggested posters. I am sure you'll like them Dorothy because they contain so many good things to eat.

Dorothy. Hurrah!

Girls. Isn't it fine, surely looks good.

Mabel. Not so fast, my dear girls. I found out that too many of these are not good for us.

Dorothy. Ah!

Mabel. (*Displays poster of carbohydrates cut from magazines.*) There are two carbohydrates, sugar and starch. Sugar gives us fuel and energy. Some of the carbohydrates are: beans, cookies, preserves, peas, hominy, potatoes, jellies, and cakes. Are there any questions?

Jean. What did you say they do for us?

Mabel. They give us fuel and energy.

Elna. What if we ate too many?

Mabel. You would be overweight.

Lucille. What if we didn't eat enough?

Mabel. You would be underweight. Are there any more?

Jean. Who had the next assignment?

Elinore. (*Displays poster of fats.*) I made a poster, too, Dorothy dear, and I found out that you must run right on past these and leave everyone for your friend Gertrude.

Dorothy. I suppose you are "cruel only to be kind."

Elinore. Don't exercise your literary trend on me; I know Shakespeare said that, but to return to the poster. Fats produce fuel and energy. The foods listed under fats are: bacon, butter, cream, cocoa, vegetable fat, animal fat, whole milk, ice cream, peanut-butter, and oils. Are there any questions?

Elna. What did you say they do for us?

Elinore. Fats produce fuel and energy.

Mary Jane. What if we eat too many fats?

Elinore. You would be too fat.

Thelma. (*Displays poster of proteins.*) I found out that we mispronounced this word yesterday. It is p-r-o-t-e-i-n-s, proteins.

Dorothy. What's in a name? A rose by another name would smell as sweet. Tell us about them.

Thelma. Proteins build muscle and tissues. Some of the things listed under proteins are: beans, cereals, cheese, eggs, fish, meat, milk, nuts, and peas. Are there any questions?

Lucille. What did you say proteins do for us?

Thelma. Proteins build muscles and tissues.

Ruby. What if we eat too many?

Thelma. You would have high blood pressure.

Jean. Good—how about the next?

Fern. (*Displays girl drinking water poster.*) Water quenches thirst, aids digestion, helps circulation, regulates the nervous system, and carries off waste matter. You should drink 6 to 8 glasses every day.

Jean. Oh, I drink more than that.

Fern. All the better, Jean.

Jean. Who had the next assignment?

Four Vitamins. We guess you had better listen to the story our posters tell. (*Shows vitamin posters.*)

Dorothy. (*Displays poster of vitamin A.*) Vitamin A promote growth and protects from certain eye diseases. Some of the things on the table of vitamin A are: string beans, peas, asparagus, cream, milk, cheeses, oranges, and tomatoes.

Jean. (*Displays poster of vitamin B.*) Vitamin B promotes growth, protects from certain digestive troubles and nerve diseases. Some of the things listed under vitamin B are: onions, milk, potatoes, cabbage, celery, pineapple, cheese, peas, asparagus, and oranges.

Lucille. (*Displays poster of vitamin C.*) Vitamin C protects from scurvy; affected by heat. Some of the things listed under vitamin C are: tomatoes, citrus fruits, milk, white potatoes, onions, strawberries, and dried beans.

Josephine. (*Displays poster of vitamin D.*) Vitamin D is essential for disease resistance. One of the common diseases is rickets. Some of the foods listed on the table of

vitamin D are: egg yolks, cod liver oil, and we should take Violet Rays.

Thelma. Will the vitamins tell the benefits of each?

Dorothy. Vitamin A promotes growth and protects from certain eye diseases.

Jean. Vitamin B promotes growth, protects from certain digestive troubles and nerve diseases.

Lucille. Vitamin C protects from scurvy; affected by heat.

Margaret. What is scurvy?

Lucille. Scurvy is a skin disease caused by not having enough fresh foods.

Josephine. Vitamin D is essential for disease resistance. A common disease is rickets.

Elna. What is rickets?

Josephine. Rickets is a disease which softens the bones, especially the bones of the legs and the spine.

Jean. Calories? Who had that topic?

Helen. A calorie is a unit of heat. It is the amount of heat needed to raise the temperature of one pound of water 4° Fahrenheit. Thus when we say that there are 3,400 calories in one pound of butter we mean that there is enough heat in it to heat 3,400 lbs. of water 4° Fahrenheit. A working man needs 3,400 calories each day and an ordinary man needs 2,000 calories. A growing child needs about 2,200 calories. To say that a person needs 3,400 calories is not the same as saying that the person must eat 1 lb. of butter a day. It means that we must eat many different kinds of food. This is one hard and fast rule — eat moderately.

Girls. I guess we had better learn to count them.

Helen. That's just what I wanted you to say! Will anyone volunteer to tell me everything they ate today?

Dorothy. I will. For breakfast I had four pancakes.

Helen. That is 500 calories.

Dorothy. A dish of oatmeal with cream.

Helen. 300 calories.

Dorothy. 2 or 3 cookies.

Helen. 150 calories.

Dorothy. 1 cup of cocoa.

Helen. 300 calories, making a total of 1250 calories for your breakfast alone. What did you have for lunch?

Dorothy. Cream of asparagus soup.

Helen. 150 calories.

Dorothy. 2 sandwiches.

Helen. 300 calories.

Dorothy. Cream frosted cake.

Helen. 400 calories.

Dorothy. A glass of milk.

Helen. 150 calories, making a total of 1000 calories for lunch. What did you have for dinner?

Dorothy. Oyster soup.

Helen. 300 calories.

Dorothy. Mashed potatoes.

Helen. 200 calories.

Dorothy. Chicken.

Helen. 400 calories.

Dorothy. Baked beans.

Helen. 300 calories.

Dorothy. Tomatoes and spaghetti.

Helen. 300 calories.

Dorothy. Chocolate pie.

Helen. 350 calories.

Dorothy. 1 cup of coffee.

Elna. You should never drink coffee.

Helen. 100, making a total of 1950 calories. Did you have any candy today?

Dorothy. Yes, 3 chocolate bars.

Helen. 600 calories.

Dorothy. And one ice-cream soda.

Helen. 350 calories. Dorothy, you have had 5,150 calories today.

Margaret. Why, Dorothy, you eat more than a workingman should.

Helen. Who else will volunteer to tell me everything they ate today?

Gertrude (*underweight*). I'll bet you want them to laugh at me, too.

Helen. What did you eat for breakfast?

Gertrude. I didn't eat any breakfast.

Helen. You should always eat breakfast. Well, what did you have for lunch?

Gertrude. 1 glass of milk.

Helen. 150 calories.

Gertrude. 1 sandwich.

Helen. 150 calories.

Gertrude. 1 orange.

Helen. 100 calories, making a total of 400 calories. What did you have for dinner?

Gertrude. Tomato soup, but no potatoes.

Helen. 125 calories.

Gertrude. Small piece of steak without bread.

Helen. 200 calories.

Gertrude. Lettuce salad.

Helen. 100 calories.

Gertrude. Cornstarch pudding.

Helen. 300 calories, making a total of 725 calories for your dinner. Gertrude you have had only 1125 calories, all day.

Elna. Why, Gertrude, I would think you'd starve.

Margaret. Hurry on, girls, I had a peek at Marie's poster and it sure is funny! She says it is her boy friend.

Girls. Show us, Marie.

Marie. (*Outline of digestive tract*) In the mouth the food is chewed and mixed with saliva which changes the starch to grape sugar. It is then swallowed. It then passes through a large tube called the esophagus, to the stomach. Here the food is churned and mixed with gastric juice, which digests the proteins. It then passes through the pylorus into the small intestine. It is now acted upon by the bile which is secreted by the liver, the pancreatic juice which is secreted by the pancreas, and the intestinal juices from the wall of the intestines. The bile aids in the digestion of fats. The pancreatic juice finishes the proteins, changes the remaining starch to sugar, and the fat to soap. The small intestine is lined with a delicate membrane which is covered with villi. These are little hairlike projections which reach down and take the part of the food that is ready to pass into blood. The remaining food passes on into the large intestine (*the colon*). It remains here for some time but is finally excreted as waste matter. The kidneys act as a filtration plant for the body.

Florence. I couldn't do that in a lifetime but I did do some reading.

Girls. Just as we expected. You do like to read, don't you, Florence?

Ruth. What did you read? Tell us!

Florence. Over Indulgence in Food as the Cause of Disease, by Kathleen Norris. (*Reads.*)

The article stated that sickness is our punishment for being greedy and thoughtless. We break the laws of the body and pay in headaches, stomach troubles, rheumatism and other ailments that are enriching patent medicine manufacturers. A great doctor says that all our ills come from overeating. It is estimated that everyone eats from three to five times too much.

Girls. Three to five times too much. That surely makes you want to tell everyone about correct eating.

Jean. (*Jumping up.*) A great idea. Let's all make a slogan and have a slogan display tomorrow.

Girls. All right!

Jean. In the meantime, balance your diet and don't eat too much.

ACT III

Recitation: "Keep Your Own Machinery Fit"

I—You know the model of your car,
You know just what its powers are.
You treat it with a deal of care,
Nor tax it more than it can bear.
But as for self that's different,
Your mechanism may be bent,
Your carburetor gone to grass,
Your engine just a rusty mass.

II—Your wheels may wobble and your gogs,
Be handed over to the dogs.
You skip and skid and run and slide,
Without a thought of what's inside.
What fools indeed we mortals are,
To lavish care upon a car,
With ne'er a bit of time to see
About our own machinery.

Slogan display. Black letters on white cardboard.

1. Keep your own machinery fit.
2. Get weighed.
3. Overweight? Work down to standard.
4. Underweight? Work up to standard.
5. Don't overeat.
6. Regulate your body with food not medicine.
7. Drink milk every day.
8. Drink 6 or 8 glasses of water daily.
9. Eat fruits and vegetables every day.
10. Exercise in the air and sunlight.
11. Sleep 9 to 10 hours with windows open.
12. Eat cereals every day.
13. Eat meat almost never.
14. Remember we eat from three to five times too much.

Curtain—the end.

If desired—Jean says, Now we will show you how we keep fit—followed by several dances which the girls have learned in their physical training.

Abstracts of Articles on Science Education

BIOLOGY

Democracy, A Biological Problem. M. F. GUYER. School Science and Mathematics, XXIX: 974-976, December, 1929. The innermost qualities of men, which determine what they shall be as citizens, are handed on as certainly as are the obvious characters of stature, complexion, and bodily structure. Successful government must be built upon these inner urges and convictions of the individual.

A successful democracy then can spring only from good blood. For this reason, democracy is a biological problem.

In the light of this fact, it becomes highly disconcerting when it is realized that the lower one-sixth of the population is producing one-half of the next generation. The great danger of any democracy is the falling birth rate among the superior and the maintained birth rate of the inferior classes. This has been the fate of past civilization and, if it continues, why not of America? The future of the United States depends upon a degree of intelligence, courage, and energy that will lead her people to deal successfully with the four chief menaces of democracy: (1) war, (2) unwise charity, (3) undesirable immigrants, and (4) relative infertility of superior stocks. The study of eminence indicates that superior capacity runs in families. Also the study of identical twins as contrasted with fraternal twins shows the power of heredity in making the former much more alike than the latter, despite environmental influences.

Forty-seven per cent of our white population grade below the mental age of thirteen, and twenty million of the people have not sufficient intellect to complete the grammar school. In 1924, seventy-six thousand persons were graduated from colleges and universities, while 93,000 were admitted to hospitals for mental diseases.

Less than 10 per cent of the feeble-minded are in institutions, while the rest are at large reproducing their kind at a rate twice that of the superior class. Perhaps a greater menace arises from the fact that there are between seven and ten millions of normal-appearing but feeble-minded carriers among our population. If all the actively feeble-minded in the United States could be blotted out today, we should have a resurgence of 100,000 active cases in the next generation coming from these carriers.

The poor quality and unrestrained fecundity of many immigrants present a serious threat to American institutions.

Since the rigors of natural selection have been eased, it becomes imperative for intelligent persons to substitute sound, intelligent personal selection, if our nation is to live and advance.—F. C. J.

Teaching Biology in the Secondary Schools. HERBERT E. WALTERS. School and Society, XXXI: 101-108, January 25, 1930.—For thirty years, periodic attempts have been made to rebuild the curriculum in biology and to formulate better methods of teaching. In this, however, one should not be discouraged. For "things that stay settled are dead and hopeless."

In achieving successful results in education, four factors are highly important, and in terms of percentage may be rated as follows: the pupil, 40%; the teacher, 30%; equipment, 10%; and the plan followed, 20%.

On the part of the pupil, his heredity is most important. "You cannot make silk purses out of sow's ears, nor can you put up two quarts of intellectual jam in a pint jar. Neither can you do justice to a two-quart jar with only a pint of intellectual jam." Individual differences must be recognized, and the teaching materials must be adapted to the pupil's ability.

Next in importance to the pupil comes the teacher. Good teachers are hard to get.

The writer recognizes the value of good equipment, but believes that the supreme values are the things of the spirit which cannot be purchased. The spirit and enthusiasm of the teacher can go far to overcome the limitations of inadequate equipment.

Planned biology teaching should be formulated to realize the following objectives: (1) to gain control of nature economically, for civilization is "based squarely on the biological business of the cultivation of crops and the production and maintenance of domestic animals. Our daily bread and meat depend upon the biology of the farm and the ranch." Moreover, a knowledge of health laws that will enable the pupil to live a strong, vigorous, and active life, are of even greater moment than those which prepare for the intellectual and social life. (2) To learn a body of organized facts about living things. This will enable the pupil to keep in sympathy with his environment, to enjoy his leisure, to have a never-failing interest in things about him, and to grow old gracefully. (3) To practice the scientific method of thinking. This is one of the greatest contributions to science. In developing the scientific method the following considerations are important:

(a) To gather facts, on the evidence of one's own senses and without recourse to authority.

(b) To arrange the facts. The encyclopedic mind is not valuable unless the facts are assorted and made available for use.

(c) To compare with other known facts. This involves wide reading, to know what has been accomplished by others, by what steps they have reached conclusions, and what value may be attached to their findings.

(d) To draw a conclusion from the facts. The ability to properly connect cause and effect gives the individual the highest and most satisfying intellectual exercise in his whole experience.

It helps to displace superstitions, such as the idea that handling toads causes warts.

(e) To verify the results. This is always a concluding and necessary step in the scientific method.

The scientific habit of mind is a greater "boon to humanity than all the material triumphs, great as they are, that characterize the science age in which we live." It helps the pupil to see that research is possible to every careful observer and thinker. For, as Dr. H. C. Bumpus has said, "research consists simply in seeing things without being told."

The best biology teachers often fall short of their goal of achievement. While valuable, the laboratory may be over-exploited. A protest is made against long, tedious exercises accompanied by extensive drawings designed to keep restless, active pupils occupied.

Finally the supreme value of the scientific attitude of mind should ever be kept uppermost. Also, the highest consideration in science teaching is a teacher with vision and pupils with innate capacity to learn.—F. C. J.

Aims in High School Biology. JEROME ISENBARGER. School Science and Mathematics, XXX, 121-122, February, 1930.—With regard to science, the need of the public schools today is a unified program extending from the lower grades through to the senior high school. This would eliminate lost motion, prevent duplication, and give the material grade sequence within the plan.

General science in the school curriculum is primarily a study of the environment. "The special sciences, physics and chemistry, on the other hand should lead to understandings of scientific principles which are illustrated by things and phenomena of the environment."

Biology takes an intermediate or transitional position. Biological subjects give the student an appreciation of the great out-of-doors and at the same time equips him with an understanding of certain principles involved in many civic and economic applications of the subject.

Biology should be presented as a course of principles and generalizations. Simultaneously the nature study or natural history phase of the subject will lead boys and girls to see and appreciate, should not be neglected. They need to understand the enormous economic import of insect injury to fruits and grains, but at the same time biology should reveal to them the "secrets of the trees, the birds, and the bees."

Above all, tenth grade pupils should find biology to be a live study of life and not a dissection of dead material. In all laboratory work living specimens should be employed which would represent at least one stage in the life history of the organism.

Teachers trained in the methods of research but unacquainted with the technique of instruction, are too likely to organize the course in terms of subject matter rather than in terms of the social needs of boys and girls. "The chief attention should be centered in the pupil rather than in the subject." Experience and pedagogical training are both invaluable to the teacher in enabling him to take a correct perspective with reference to the aims to be accomplished.
—F. C. J.

History of Biology in the High Schools of Chicago. WARRALO WHITNEY. School Science and Mathematics, 30: 148-152, 1930.—A short paper on the introduction and development of biology in the high schools of Chicago, written by a teacher who has been identified with many of the incidents described in the paper.

The author points out that biology as a laboratory subject was first included in the science work of the Chicago schools in 1892, when biology was made a required subject in the high school curriculum. The difficulties involved in securing outlines of courses, reading materials, text books, are covered rather fully.—E. R. G.

Utilizing the Natural Interests of Pupils in Teaching Biology. O. D. FRANK. School Science and Mathematics, 30:30-41; 161-165; 265-271; 396-399. 1930.—A series of articles of great value to teachers of biology, general science and elementary school science. The first paper concerns notebooks, animal tracks, growth of trees, insect life histories, and suggestions for field trips.

The second paper discusses seed study, earthworms, leaf life histories, raising silkworms, and several additional subjects.

The third paper contains a detailed outline for a study of the apple, also one for the orange. Many suggestions are given on the place of collections in science work, the use of the camera, blueprints, nature poem booklets, and methods for exchanging collections are discussed in some detail.

The fourth paper discusses the balanced aquarium, the cricket garage, bacteria cultures, electric charts, victrola day, and methods for keeping a record of science readings.

Teachers who believe that science instruction should rest on experience in concrete situations, will find many valuable suggestions in this series of papers that can be used very effectively in either elementary or high school science classes.—E. R. G.

An Analysis of Biological Drawings. AMER M. BELLEW. School Science and Mathematics, 30:490-497, 1930.—This is a summary of a study of drawings in high school zoology as aids to the pupil in making analytical observations and in remembering observations. None of the original data are included in the article, though a citation is given to another paper published in School Review, Vol. 36, pages 284-295.

The author concludes that representative drawings are of little value in assisting the student to make analytical observations or to remember accurately the details of observations.

Analytical drawings in biology are regarded as valuable for securing both analysis and retention. The author recommends that the emphasis in drawings should be shifted from the artistic, pictorial type of notebook work to analytical drawings that apparently give better training.—E. R. G.

The Contents of the Biology Course. ALFRED C. KINSEY. School Science and Mathematics, 30:374-384, 1930.—An article of opinion, giving in detail the pros and cons underlying the organization of a high school course in biology, with respect to the following issues:

1. Shall the course consist of one-half year of botany, or one-half year of zoology ?
2. Shall the course be a detailed study of a limited number of species that illustrate major classes?
3. Shall the course be exclusively physiology and morphology, or a resumé of several sub-sciences.
4. Shall the course emphasize pure science or applied science, especially with respect to human hygiene and sanitation?

These issues and others are discussed critically by an author of one of the recent biology textbooks.—E. R. G.

CHEMISTRY

The Story of Aluminum. HARRY N. HOLMES. Journal of Chemical Education, VII:233-244, February, 1930. "The story of Charles M. Hall, like the classics, will be told many times, but it will never lose its appeal to the imagination." Professor Holmes reviews briefly the story of Hall's interest in the problem of producing aluminum from its ore, quoting at some length from Hall's address on the occasion of his reception of the Pekin Medal in 1911.—C. J. P.

The Problem of Problems in High School Chemistry. PAUL K. WINTER. Journal of Chemical Education, VII: 355-357, February, 1930. More discussion on the *gas law problems*, including an attempt to have students rationalize their chemical calculations involving the laws.—C. J. P.

Do Students Who Study Chemistry in High School Elect That Subject in College? CLIFF R. OTTO *and* MABEL CLAIRE INLOW. School Science and Mathematics, 30: 292-294, 1930.—This brief paper concerns 906 graduates of a State Teachers College, with respect to chemistry studied in high school and in college.

The authors find that 11 per cent of the students entered the college with high school chemistry; 50 per cent of these students did not study chemistry in high school or college. Among the students who did not elect chemistry in secondary schools, 4 per cent of this number were found to have studied college chemistry. In general, only 50 per cent of the students studying chemistry in high school studied the subject in college.

The authors conclude that the teaching of chemistry in high schools does not encourage the election of college chemistry to any appreciable extent.—E. R. G.

GENERAL SCIENCE

A Comparison of Two Methods of Teaching one Problem in General Science. J. E. CORBALLY. School Review, XXXVIII: 61-66, January, 1930.—There is great need for objective studies relating to the effectiveness of various methods of teaching science. The writer points out accepted weakness of the traditional class recitation and then proceeds to give comparitive results of teaching one problem in general science to classes "of about the same average intelligence" by the "class recitation" and the "unit method." The data, though not elaborate, are interesting. The conclusion is: "The results of the investigation tend to show that neither method of teaching is ditinctly superior to the other. The determining factor is the teacher, not the method or device."—C. J. P.

Some Problems Relating to Exploratory Courses. E. C. CLINE. School Review, XXXVIII: 206-210, March, 1930.—A brief statement of the criteria of exploratory courses in the junior high school and a reference to the chilled ardor of administrative officers for "general" courses are followed by a characterization of two entirely different methods of exploration. The first is the "try-out" course; the second is the general introductory course. General science is described as successful introductory course in the field of science.—C. J. P.

The Effects of Previous Upon Subsequent Courses in Science. A. W. HURD. Educational Administration and Supervision, XVII: 144-146, February, 1930.—This article reports briefly the results of a study of the effects of a course in general science upon a subsequent course in physics by determining for physics students not having general science and those having general science the gains made in twelve units of the physics course. Initial and final tests were given for each unit in each group of students. Several conditions are indicated by the data obtained:

"1. Differences in mean scores on pretests show that in some respects those having general science are superior as groups. . . ."

"2. Differences between groups (those having and those not having general science) seem somewhat accentuated in the final tests."

According to the writer, the data indicated further: (a) that a course in general science helps in some fields of physics, notably electric lighting and heating, ventilating and humidifying; (b) that

in more unrelated fields there is apparently less indication; (c) that there seem no general ablities gained from general science which carry over into the field of physics, and (d) that there is no selective function of general science to sort out students of superior ability.

It is unfortunate that the reader is not shown the tests upon which the study is based, nor is there given a reference to these tests.—C. J. P.

PHYSICS

An Experiment in Directing Thinking in Physics. IRENE R. BLANK. School of Education Journal of the University of Pittsburgh, March, 1930, p. 90-96.—Equated groups of pupils (experimental and control) were used to evaluate a "Study Guide Method." This method was used during two school years in heat, sound, and light. Objective test scores are the criteria of achievement. The statistical treatment of the data is adequate and the conclusions fairly well substantiated, though in no case does the critical ratio reach the degree of certainty.

Indications are that the "study guide" tends to increase measured achievement. The experimenter gives testimony that pupils respond well to the guide. The guide, itself, is not explained in the article.
—A. W. H.

Objectives of a Proposed Course of Study in Physics for Senior High Schools. G. C. MUTHERSBAUGH. School Science and Mathematics, XXIX: 943-954, December, 1929.—A summary of this study is given in the first paragraph of the published article: "The purpose of this study is (1) to determine the specific objectives in physics as found in textbooks, courses of study and physics treatises, and (2) to indicate the frequency of occurrence in these sources. After the least important objectives have been eliminated, the final list, selected on the basis of usefulness, interest and frequency, will yield a much more reliable course of study than that in use at the present time."

Two hundred forty-two specific objectives are finally listed, the first 221 being selected as indicated in the first paragraph from an original list of 1018. Twenty-one new objectives are added by the author.—A. W. H.

A Study of the Contents of the Laboratory Course in High School Physics. E. W. KIEBLER and FRANCIS D. CURTIS. School Science and Mathematics, XXIX: 980-85, December, 1929.—Laboratory exercises found in eight laboratory manuals were listed and sent to several hundred experts for evaluation. Ninety-one judgments on the points (1) essential, (2) desirable, and (3) undesirable, were received. Final lists of exercises are given in the article, showing (a) the number of manuals giving each, (b) the number of ratings of 91 including it, and (c) the average rating value, based apparently on these two criteria. The data are given so that a teacher of physics may have some objective criteria to use in selecting exercises for the laboratory.—A. W. H.

Reorganization in Physics. A. W. HURD. The North Central Association Quarterly, IV: 227-293, September, 1929.—A list of 19 teaching units are given in the article, the selection being based on an objective analysis of the literature on the teaching of physics written from 1900-1926; and a subjective use of the ultimate and immediate aims of the North Central Association of College and Secondary Schools as set forth by the Sub-Committee on Standards of the Commission of Unit Courses and Curricula.

Unit I and Test I are printed in full and some data obtained from unit tryouts are included. The data bear upon preliminary and final test ratings of (1) all students; (2) those having and those not having a previous course in General Science; and (3) seniors and juniors. Numbers and per cents of pupils giving correct responses to some test items are also given, together with a partial list of possible extra projects to be engaged in by more capable pupils.

Each unit is planned to contain a list of common activities for all pupils, suggested supplementary activities for capable pupils, and a list of suggested reference books.—A. W. H.

Better Demonstrations in Physics. N. HENRY BLACK. School Science and Mathematics, 30:366-373, 1930.—An excellent paper describing lecture demonstrations with: electroscope; projection of string vibrations; continuous spectrum; absorption spectrum; bright line spectrum; and a color mixer,—all the demonstrations being performed with an arc light. Six illustrations are included.

The author urges science teachers to study the recent catalogs of such foreign dealers in laboratory apparatus as E. Leybold's Nachfolger in Cologne, and Max Kohl in Chemnitz.

Teachers of college physics and of physics in the larger high schools will find this article of great value. An enormous improvement could be brought about in the teaching of light in the smaller schools, if the equipment as described were available for use.—E. R. G.

Is High School Mathematics an Adequate Preparation for High School Physics? JEROME G. LEMMER. School Science and Mathematics, 30:41-44, 1930.—A brief study of data obtained by giving an inventory test for mathematics needed in high school physics to third-year high school physics classes. The results from seventy-seven pupils are analyzed with respect to the deficiencies revealed in arithmetic, algebra, and geometry.

The conclusions to be drawn from this study may not be regarded as valid, since a relatively small group of pupils was tested. However, the data indicate that even a superior group of high school physics students are not able to do successfully the simple tasks in algebra, arithmetic, and geometry that are required in doing satisfactory work with the numerical problems of high school physics.

This study is an example of a growing number of detailed investigations that will ultimately show how to secure better learning in this subject.—E. R. G.

SCIENCE TEACHING

Problems of Science Teaching at the College Level. ARCHER WILLIS HURD, University of Minnesota Press, Minneapolis, Minnesota, 1929.—The studies included in the volume are as follows:

1. To determine the possibilities of limiting the number of cadavers for use in the laboratory in human anatomy.
2. To investigate the possibilities in the partial replacement of laboratory work in human physiology by library work.
3. To investigate the possibilities in limiting the time given to laboratory work in human physiology.
4. To investigate the value of laboratory work in "Mechanics."
5. To investigate the effect of class size in "Heat."
6. To investigate the effect of class size and other determinants of achievement in "Electricity and Magnetism."

Accounts of these studies are preceded by a chapter reviewing previous experimental studies made in the college and secondary school field.

While the findings themselves are significant, probably the primary values inhere in the several techniques used and the underlying logic of these techniques.

For the experiments, objective tests were constructed and validated; techniques of matching students for experimentation investigated; and student and faculty opinion secured and tabulated. The following criteria for the judgment of conclusions were used in the several studies

1. The achievements of individual students paired on one or two bases, which are thought to be best from past experience.
2. The achievement of equated groups based on equality in one or two bases which are thought to be best from past experience.
3. The achievements of equated groups based on many past ratings (including psychological tests), any or all of which may be significant.
4. The achievements of individual students, paired on bases which are proven to be significant.
5. The achievements of groups, equated on bases which are proven to be significant.
6. The achievements of groups, not equated, but which are found comparable on many past ratings and may be compared, therefore, in of achievement in "Electricity and Magnetism."
7. The achievements of a group showing a peculiar variation from several other groups which are selected on a similar basis.
8. The achievements of a group judged from that of a smaller group shown to be equivalent to a random sampling.
9. The achievements of individual students exposed in turn to different methods, the effect of one method being obviated by halving the groups and using alternative methods with each half initially.
10. The achievements of random samples of students from classes over a period of years, on the assumption that chance will equate the groups.

"No particular criterion was shown to be superior to any other. The highest probability would be expected from the use of as many as possible, each one acting as a check on the other. If any basis of pairing could be proven significant so as to yield a coefficient of .90 or higher, the procedure of pairing students on this basis would be justified. Apparently, there are no such proven bases as yet. There may be in the future, but there is no proof that there will be."

Statistical data are supplied in support of the following conclusions:

1. There is no evidence, except individual opinion, to warrant the belief that, under the conditions existing in the Anatomy Department of the University of Minnesota, one cadaver for each two students is more advantageous than one for each four students, as far as the measure of achievement employed could determine.
2. There is some evidence to indicate that seven and one-half hours of laboratory work in human physiology, as carried on in the Medical School of the University of Minnesota, produce measurable achievement in excess of that produced by five hours of laboratory work plus two and one-half hours of library work.
3. It has been shown that the addition of laboratory work in the course in elementary physics (mechanics) at the University of Minnesota on the part of architectural students would raise their achievement records in certain specific items associated with laboratory activities. There is no evidence, however, to show increased achievement in items associated with the other activities of the course.
4. There is additional evidence that class size is not a significant factor in achievement in elementary physics under present instructional conditions. Achievement seems to be more a matter of individual incentive, capacity, and effort.
5. Existing measures of educational products need further study and improvement. Many abilities, presumably developed by science

instruction, have not been objectively measured and there is no objective proof that the claims are just.

6. Abilities presumably gained in the laboratory have not been measured objectively as yet, though a beginning was made in this study in the laboratory items incorporated in the second objective test used in mechanics.

7. Subjective opinion largely determines present instructional practices in science.

8. M scores serve as convenient and valuable means of expressing all ratings. They are then expressed in readily comparable units.

9. Raw scores in classroom tests are as valuable for certain purposes of comparison as scores where individual questions are given a weighted scale value.

10. Evidence shows that the method of weighting letter marks in a given subject has no effect on the correlations obtained when these ratings are used as one variable. No evidence is given, however, to show that the same weighting for all subject letter marks does not affect the correlations.

11. Some objective evidence is given to show that new type tests involve mental functions not involved in the conventional types.

12. A majority of students in the experiment in mechanics preferred objective tests. Judged by the frequency of mention, the primary reason is that they cover more ground and thus give the student more chance to show what he knows. A combination of conventional and objective tests is probably desirable.

13. There is objective evidence in the large percentage of cancellations and failures, that either the subject of mechanics is not adapted to student needs, or, that the students are not prepared to undertake the work.

14. Subjective opinion from three questionnaire returns indicated that the main function of the laboratory is to give the student acquaintance with scientific apparatus and develop skill in its use, and to furnish concrete material for illustration and verification.

15. Student opinion indicates a desire that mechanics may be more practical, more illustrative of applications of physical principles, and less theoretical and mathematical.

16. Evidence shows that factors other than intelligence are powerful at the college level, or that the intelligence tests do not measure certain features of intelligence which are operative in college work especially.

17. Objective tests in mechanics at the University of Minnesota show that students who have studied high school physics are greatly superior at the beginning of the course to those who have not studied it.

18. Students enrolled in mechanics who have studied high school physics are not of significantly higher rating in the freshmen entrance test scores than those who have not studied high school physics.

19. Achievement in mechanics is significantly higher on the average for those who have had high school physics. The difference is much less, however, than initial differences in the preliminary test covering the field of high school physics. Success in high school physics contributes to success in university physics in this case, but the lack of the former does not prohibit success in the latter. Either large initial differences due to the study of high school physics are much diminished during the course in mechanics, or the content in mechanics is sufficiently different to discount initial differences in high school physics.

The last chapter is supplementary to the previous chapters and the conclusions are given separately as follows:

1. No differences in achievement between the members of large and small class groups due to class size are noticeable.
2. New type objective examinations in magnetism and electricity are not found to be any more valid than conventional examinations, using the final quarter mark as a criterion of validity.
3. No valid criteria for pairing students for experimental work in method were found in this study.
4. Students having had high school physics show a tendency on the average to rate higher in the University course in magnetism and electricity at Minnesota, but they are not markedly superior to those not having had the high school course.
5. Students having had high school physics rate significantly higher, on the average, in a test covering the content of high school work in magnetism and electricity than those not having had the high school course.
6. Students in both *high school* and *university* show surprisingly low percentages of correct responses to items covering the respective courses in electricity and magnetism. Either the expectations of instructors are too high, the questions are too difficult, or the students do not measure up to reasonable standards.
7. The number of sciences studied in high school serves as no reliable criterion of achievement in the university courses in physics.
8. Students taking mechanics and heat, or mechanics, heat and optics in the University do better, on the average, than those taking mechanics alone, in the course in electricity and magnetism. The students taking heat alone in addition to mechanics do as well as those taking optics and heat.

Superstition and Science Teaching. J. O. FRANK. School Science and Mathematics, 30: 277-282, 1930.—This paper is a summary of an investigation started in 1924 in the State Teachers College, Oshkosh, Wisconsin, and includes three and one-half pages of tables giving detailed descriptions of the common superstitions found in the Fox River Valley of Wisconsin.

This list of common superstitions may astonish science teachers. Nevertheless, they deserve very careful scrutiny, because some of them may be much more common than is suspected. The author finds that a total of 1,224 superstitious beliefs were identified in the investigation. 175 of these concerned luck; 126 of them concerned death; 108, the weather; 66, omens; 52, wishes; 44, prevention of diseases. Other data will be found in the original paper.—E. R. G.

The Training of Science Teachers, Here and Abroad. N. HENRY BLACK. School Science and Mathematics, 30: 153-160, 1930. — This paper discusses briefly the recent study made of high school science in the city of New York; what science teachers teach in the state of Ohio; the training of chemistry teachers with respect to the subject-matter of chemistry and education courses; also the total years of experience of chemistry teachers.

The academic training needed for the science teacher is described in some detail; also the professional training that should accompany the science subject-matter courses. The proposed two-year requirement for the Master's Degree in Harvard University is discussed from the point of view of training science teachers.

Two pages of the paper are devoted to the training of science teachers in the secondary schools of England, France, and Germany.

The paper is worthy of careful study by those who are concerned with the training of science teachers.—E. R. G.

Secondary Education. CARL A. JESSEN. Bulletin No. 22, 1929, United States Office of Education.—Those interested in science education are always eager to know how their "subject" is faring in the public schools. This bulletin presents the latest general data on enrolment of high school subjects. More complete data will appear in the Biennial Survey of Education, soon to be published. We quote:

"At the time of writing, incomplete tabulations have been made for nine states, namely, California, Iowa, Louisiana, Massachusetts, Minnesota, New Jersey, Ohio, Texas, and Washington.

"In these states 609,893 pupils were enrolled in the schools which have reported. The percentages which the enrolments in various subjects were of this total enrolment are indicated in Table I. To show trends, parallel percentages are given for subject enrolments in the same nine states in 1922, when the last previous tabulation of this kind was made by the Bureau of Education. The number of high-school subjects reported by these states in 1928 was 243. In order to make the items for 1928 and 1922 comparable in Table I, it was necessary greatly to reduce this number by grouping subjects.

"Emphasis, as measured by pupil enrolment in the various major departments, is in the following order: English, social studies, mathematics, science, commercial subjects, and foreign languages. In 1922 the order was, English, social studies, mathematics, science, foreign languages, and commercial subjects. The most pronounced increase in enrolment has taken place in English and in commercial work; social studies and science enrolments have remained relatively stationary; mathematics and foreign languages have lost.

"Among individual subjects it is apparent that American history is gaining at the expense of foreign history; general mathematics is making inroads into enrolments in algebra and geometry; biology and hygiene and sanitation show material increases; physics is losing; physiography and physiology are receding in importance; botany and zoology have almost disappeared as separate subjects; all the foreign languages most frequently taught have dropped in percentage of pupils registered; in commercial work bookkeeping has lost, while typewriting, commercial law, commercial geography, office practice, and business organization register increasing numbers of pupils; home economics enrolments show a substantial increase; mechanical drawing is becoming important in the number of pupils enrolled; physical education has had more convincing growth in enrolment than any other major individual subject."

Figures for science taken from Table I of the report are as follows: Percentages of Pupils in Nine States Enrolled in Various High School Subjects, 1928 and 1922:

Subject	*Percentage of Enrolment*, 1928	*Percentage of Enrolment*, 1922
Physics	6.83	9.13
Chemistry	7.84	7.99
General Science	18.12	17.83
Physical Geography	2.36	3.80
Botany	1.19	2.86
Zoology	0.32	1.04
Biology	11.41	7.12
Physiology	2.26	5.20
Hygiene and Sanitation	6.60	4.54
Other science	0.96	0.24

—C. J. P.

Educational Philosophy—Change, Invariance, or Both? H. B. LOOMIS. School Review, XXXVIII: 256-262, April, 1930.—The writer voices his objections to the modern educational philosophy change, particularly as expressed by Kilpatrick in his *Education for a Chang-*

ing Civilization. He maintains that a philosophy of invariance is desirable in meeting a changing civilization and uses particularly the advances in science to illustrate his philosophy. He says, in his conclusion to his argument in the field of science:

"Nothing definite in this field can be done without a profound knowledge of the laws of physics that have already been established. A thorough knowledge of the invariants already established is our only hope in meeting an unknown future. It would seem, then, that the objectives of education in the physical sciences should be threefold: first, training in the methods by which scientists discover invariants; second, training in the methods by which inventors apply these invariants; and, third, knowledge of the most far-reaching invariants and of their most important applications. The third objective indicates the subject-matter of a science course, while the methods of teaching are suggested by the first and second objectives."

And in conclusion to his article:

"On the supposition that the illustrations given in this article are typical, it would seem that the path of progress in the physical sciences, the path of progress in the social sciences, and the path of progress in education are essentially the same. Learn the past; observe the present; and look for invariants—the factors that remain unchanged in the realm of abstract, no matter how great the changes in the realm of the concrete. After testing in critical cases the validity of apparent invariants, hold fast to those that stand the test and use them to make the world of change do your will, for in the knowledge or invariants lies the power partly to control the changes of the future."—C. J. P.

How Many and What Subjects Should a High-School Teacher in Pennsylvania Prepare to Teach? J. S. HEIGES. School Review, XXXVIII: 286-299, April, 1930.—Through a survey of reports submitted by high school principals and superintendents, the distribution of specific subjects assigned to teachers were determined. It was found that of 7,834 teachers in 716 high schools, 71.1% teach but one subject, 25.5% teach two subjects, 3.3% teach three subjects, and .1% teach four subjects. The percents vary, of course, with the size of the school. Of the 1,343 science teachers in 716 schools, consisting of four-year high schools, six-year high schools, and three-year senior high schools, 52.9% teach one subject only, 39.5% teach one additional subject, 7.1% teach two additional subjects, and .4% teach three extra subjects. The author's conclusions include the following suggestions of significance to prospective science teachers in Pennsylvania: "(1) Prospective teachers need to make preparation to teach not more than two subjects; (2) Prospective teachers for schools having eleven or more teachers—that is, for the schools in the first two divisions—need to prepare to teach but one subject; (3) Prospective teachers for the schools having less than eleven teachers need to prepare in two subjects." He further shows that the minor subjects most frequently combined with science are mathematics, history and English.—C. J. P.

Further Comments on the Scoring of Continuity Tests. HOWARD E. WILSON. School Review, XXXVIII: 115-123, February, 1930.—The article carries forward the discussion concerning the technique of marking continuity tests. While the discussion relates directly to the teaching of history, there are valuable suggestions to the teacher of science in the direction of formulating and scoring tests which involve the historical sequence of discoveries and inventions and also the sequence of ideas in scientific problem-solving.—C. J. P.

Evaluating Books on Vocational Guidance. R. C. WOELLNER and R. L. LYMAN. School Review, XXXVIII: 191-199, March, 1930.—Following a brief statement of methods of determining merits of books for school use, the writers propose the use of (a) the assembled judgments of a group of workers who are capable of rendering reliable opinions, and (b) the recitations of children, both as to their understanding and as to their enjoyment and appreciation of the books. A score card for evaluating vocational books is given and the scores on 26 books as rated by 103 teachers are presented. A later article will report an evaluation of the books by ninth-grade pupils. The list of books, as well as the method of rating them, will be of great interest to science teachers. Many of the books listed should be a part of the science library.—C. J. P.

The New Books

Songs of Science—1930—Virginia Shortridge—245 pages—Marshall Jones Company, Boston.

"Songs of Science" is an anthology of the poetry of reason. In her prologue Miss Shortridge says that her aim has been to "link the advance of Science with the rhythmic evolution of Beauty, and the revelation of knowledge, which is permitting men to lift the veil between the concrete and the ideal, as it is expressed in terms of poetry.

The anthology is made up of more than two hundred complete poems and many excerpts The selection evidences a nice poetic discrimination and a sensitiveness to the ecstasy of the systematic search for understanding. These two qualities make the book highly satisfying to the mature student of science and vividly inspiring to the novice. The anthology is sure to delight the lover of sound poetry as well, for there are many excellent unfamiliar verses in it.

The poems are thematically chaptered, but the good taste of the anthologist has not permitted the usual encyclopedic brittleness. The volume is indexed and pleasingly bound.—C. E. RENN.

Specimen Objective Examinations—1930—G. M. Ruch and G. A. Rice 324 pages—Scott, Foresman and Company, Chicago.

During the year 1928-1929 the authors conducted a contest of national character in connection with which four hundred new-type examinations in eight different subjects were submitted. The examinations in the various subjects were judged by groups of specialists. This volume contains the examinations which won prizes and honorable mentions. The introduction to the volume will be of particular significance to teachers because it lists the various types of examinations which were submitted, and discusses at some length the trends in objective examination practices. Sixty-six examinations in the national sciences were submitted. Seventeen of these were, after the preliminary elimination process carried out at the University of California, judged by three experts in the field of science education. The five examinations receiving prizes and mention are given in the volume. No teacher of science should fail to examine this volume.—C. J. P.

Flowers and Flowering Plants—1929—Raymond J. Pool—\$3.50—McGraw-Hill Book Company, New York.

Professor Raymond Pool, of the Department of Botany, University of Nebraska, has in this volume done two things: As he sets forth in his sub-title, he gives the reader an introduction to the "nature and work of flowers." He deals simply but very completely with the morphology, described from a genetic standpoint, of flowers, fruits and seeds, and combines with this exposition statements concerning certain adaptations and specific distributions.

The latter part of the book is concerned with taxonomy. Following a description of the system proposed by Linnaeus, the systematic classifications of de Candolle, Endlicher, Hooker, Eichler, Engler and Bessy are displayed in a form that permits of easy comparison. Then the author's system: Certain selected orders and families described in detail. Pictures of diagnostic parts of these families are very beautifully reproduced in semi-diagramatic line-engravings, and again quoting the author, "new types of graphic formulae and charts are used to depict floral anatomy and evolution."

A rather practical chapter on collecting, cataloguing, and caring for specimens is at the end of the book. The last chapter provides a bibliography that would enable a college student in botany to explore further into the field of references and lead him to monographs, manuals, and descriptions of flora. A new map, which shows the approximate ranges of a number of useful manuals dealing with classification, is presented in the chapter of reference books, which ought to be very useful to one new to a locality who needs a guidebook for the flora of a special section of our country.

The book seems very complete, if a person's interest in Botany is from the morphological, genetic, and historical point of view. There is little or no ecology, no physiology, and very little that is concerned with economic relationships of plants in the volume. As the author states in his preface, the book should serve excellently "for those who have had an introduction to general botany, and those who would studiously read other books," if they would get a well-rounded view of the field.

As a reference book for a teacher of biology or general science, the book commends itself because it is readable. Although scientific terms are introduced and used along with the general and specific names of the types described, the author uses common names as well and makes it possible for the book to be enjoyed by anyone who knows introductory botany.—F. M. WHEAT.

Science in the Service of Health—1930—Elliot R. Downing—320 pages—118 illustrations—$2.00—Longmans, Green and Company.

This book will fascinate you. It is full of supplementary material, particularly historical and biographical material, bearing upon many topics which are so briefly touched in our ordinary science courses. It also gives a glimpse at least of how the minds of many of our science masters worked. The chapter titles are as follows: The Pioneer; Bacteria Cause Disease; Prevention and Cure of Disease; Insects as Disease Carriers; The War on Disease Continues; The Effect of these Discoveries; Early Ideas of the Human Body and Its Work; Malphigi and His Times; Rival Physical and Chemical Theories; New Light on Respiration; Some Discoverers of Nutrition and Growth.

Stuff—1930—Pauline G. Beery—304 pages—102 illustrations—$5.00—D. Appleton and Company.

This is a "story of materials in the service of man." It is a book for all ages and describes the discoveries in practical science which have impressed raw materials and natural forces into the everyday service of man. Nor does it neglect theory, for along with such topics as "textiles from test tubes" and "rainy day apparel," we find "the structure of stuff," "seeing through stuff" and "stuff of the future." We quote from the preface: "Man's progress from age to age has depended upon the number of materials which he knew how to secure and use. Commerce between nations is the result of a desire to obtain new kinds or greater quantities of stuff from other lands. Wars have been fought to get possession of regions where certain important stuffs can be secured. Much of man's history is thus the story of his search for the stuff which will be of service to him."

The New Evolution: Zoogenesis—1930—Austin H. Clark—297 pages—illustrated—$3.00—Williams and Wilkinson Company.

Science teachers, as well as others interested, should become familiar with the new concept of evolution which is given in this book under the coined name *Zoogenesis*. According to the author,, "as man and man-like apes are both very highly specialized, but are specialized in widely different directions, we cannot suppose that either descended from the other, or indeed that there is any very close relation between them." And he then goes on to say: "Yet, since both man and the apes belong to the same division of mammals—the Primates—and we cannot doubt their continuity of life from parent to child from the very first, man and the apes have had at some time in the past a common ancestor."

The Classroom Guide to the Book of Knowledge—1929—Ellis C. Persing and Staff—591 pages—The Grolier Society, 2 West 45th St., New York.

Although most pupils show much interest in the Book of Knowledge and are eager for an opportunity to read it, many teachers have found the books were not giving the return one might expect from them. Directed reading or study for individuals in the class can hardly be expected of a teacher to the extent of preparing outlines for all the subjects treated. That arduous task has now been accomplished and is presented in the *Classroom Guide*. The subject-matter is divided into ten large units of study: geography, history, biology, poetry, art, science, health, stories, character education, and factual reading. There are 77 topics treated under *science*, and nearly as many more under biology. These lesson helps include suggestions given under these headings: purpose, suggested procedure, what to look for, questions, picture study, other references. Specific page references are given. The subject-matter covered in these topics is well worth while. The many pictures are helpful and the questions are thought provoking. It would be hard to find the equal of this work as an aid to supplementary class work, for elementary science, nature study, elementary biology, and health study. If you wish to enrich your class work by supplementary material outside the text, we believe this will be of great assistance to you.

The Romance of the Machine—1930—Michael Pupin—111 pages—$1.00—Charles Scribners Sons.

"The machine which has transformed the habits of man is a creation more romantic and more astounding than the greatest poetry. The birth and growth of the machine is the story Professor Pupin tells genially, interestingly, forcefully." There are three chapters: The Romance of the Machine; Washington's and Lincoln's Admiration of the Machine; Romance of the Telephone.

A Technique for Developing Content for a Professional Course in Science for Teachers in Elementary Schools—1930—Florence G. Billig—101 pages—Bureau of Publications, Teachers College, Columbia University.

This report of Miss Billig's investigation and study is of special interest to students of science education. It opens up tremendous possibilities for those who are in a position to carry on the study and make further contributions towards the development of a professional course in science for teachers in elementary schools. It comprises five chapters as follows: An analysis of the Problem; Technique Used in Selecting Core and Marginal Content; The Organization of Content into Teaching Units; Analysis of Scientific Background of Students Enrolled in Courses in Science for Teachers in Elementary Schools; Summary of the findings of the Study with Recommendations for the Use in Developing a Professional Course in Science.

Elementary Inorganic Chemistry—J. W. Mellor, D.Sc., F.R.S.—Longmans, Green & Company, New York—1930—$1.50.

To generalize from a single example is quite unscientific. Yet I come from the reading of Professor Mellor's latest text with the feeling that it is decidedly *English*. Few elementary texts from English schoolmasters appear in the American market. This is to be regretted—if we may generalize again from this sample—for it is quite refreshing to stroll rather than dash through the field of chemistry. One sees so much more by the roadside when he isn't trying to catch a train. This is the impression I get from this text: it is a leisurely, unhurried, scholarly—almost artistic introduction to this fascinating field of science.

The question might be asked, "Why is a text-book?" Various answers—if we are to judge by the books on the market—seem to satisfy various authors. Some say an encyclopedia; some say a catalog; others say tables and outlines; questions and answers, pictures, and so through the various types. But the answer of this volume is, *a real book*—a book which has a style and a purpose; which is scientifically sound but is inspiring as well as informative. When such an eminent authority as Professor Mellor invades the elementary field, we could expect something worth while. This is my judgment of this entirely new text: *it is worth while.*

The scope of the book is just about adequate for a half-year course. The elements: Oxygen, Hydrogen, Nitrogen, Chlorine, Carbon, Sulphur and Phosphorus, with their most common compounds and their relationships to the development of chemical theory and to daily life, are very thoroughly treated. By "thoroughly" I mean—not exhaustively, not pedantically—but carefully, with ample illustration, with thoughtful co-ordination and with extraordinary understanding of the beginners' difficulties.

Two outstanding features must be noted. First, is the emphasis upon and development of, the concept of *scientific method.* Much loose talk has been made recently about "scientific thinking" and the "scientific attitude." Here in this volume we have at least one way of attempting to present the essentials of this important phase of science teaching in an adequate manner—and at the level of secondary school pupils. "Hypothesis," "Experiment," "Verification," "Facts and Theory," these all must become meaningful to the student who finds them used, not once but repeatedly—and in real problematic situations arising in the fascinating historical development of chemical theory. The second outstanding feature is the emphasis upon men—men who did things; who were courageous, who were persistent; who were often wrong but who were searching for the truth. These men were adventurers, and their adventures are so interwoven into the story that it can scarcely fail to appeal to boys.

In size, in print, in adequacy of cuts and pictures, and in organization of material, the book is likewise well done. Some might wish more summary questions at the end of the chapters. But those given are thought-provoking, appropriate, at the pupils' level and, in the opinion of the present writer, numerous enough for class instruction. If this review seems to portray a book too good to be true, read the book and be convinced! —*R. E. Horton.*

Recognition of Science Achievements of High School Students

There is a plan for a co-operative venture relative to modern science which will probably be of interest to teachers of science, of English, of history, and to librarians and school officials. This plan has been announced by the Committee on the Place of Science in Education, of the American Association for the Advancement of Science. It is desired that all science teachers, teachers of other related subjects, and science students should know of this movement. You may wish to encourage some of your own pupils to engage in this proposed work. We would like to hear from all who may wish to participate in the venture.

For several years suggestions have been made to the Committee regarding some such work as that now announced. There is danger of harm rather than of help when too many agencies attempt to develop essay contests by high school students. It is hoped, however, that this plan avoids the objectionable aspects of essay contests, and makes use of certain important and desirable features. That the plan appeals to school officials as being desirable is shown by extended quotations from representative school men, a copy of which will be sent to you. Since the school men who have made these reports include superintendents and principals from various parts of the country, it is thought likely that their attitude is representative of school officials in general.

It will be of great importance if secondary school teachers respond to this opportunity for co-operation with the A. A. A. S., which is the largest and most influential organization of science men in the world. Outstanding success of this movement may lead to other important relationships and developments.

The Committee proposes to encourage those students of the school who have ability and the inclination to make a personal study on some topic and to write an essay upon it. The prizes include money for the school library, recommendation for scholarship in college, possible publication, and lastly "personal satisfaction of having done an outstanding piece of work worthy of general recognition." The date when this material must be submitted is March 15, 1931. For complete information write to Committe on Place of Science in Education, 433 West 123rd Street, New York, N. Y.

THE EXECUTIVE COMMITTEE,

Otis W. Caldwell, *Chairman*

J. McK. Cattell I. W. Howerth

E. R. Downing B. E. Livingston

Science Articles in Current Periodicals

HEALTH

Arthritis. Hygeia, 8 : 521, June, 1930.
Can the World Banish Malaria? Sci. Am., 142 :270, Apr. 1930.
Farsightedness. Hygeia, 8 : 536, June, 1930.
Health the Biggest Business. Hygeia, 8 : 421, May, 1930.
Proper Posture. Hygeia, 7 :1205, Dec., 1929.

FLORIDA

The Fountain of Youth. Nat. Geog. Mag., 57 : 1, Jan. 1930.

GENERAL SCIENCE

Planet X. Sci. Am. 143 : 20, July, 1930.
New Concept of Matter. Sc. Am. 143 : 38, July, 1930.
Printing Processes.
I. Depressed Surface Printing. Jo. Chem. Ed., 7 : 1028, May, 1930.
II. Surface Process. Jo. Chem. Ed., 7 : 1263, June, 1930.
III. Relief Printing. Jo. Chem. Ed., 7 : 1632, July, 1930.
Science in the Modern World. Jo. Chem. Ed., 7 : 1061, May, 1930.

LOUISIANA

Land of Perpetual Romance. Nat. Geog. Mag., 57 : 393, Apr. 1930.

MOTION PICTURES

Industrial Motion Pictures in Classroom. Jo. Chem. Sd., 6 :1736, Oct. 1929.

PHOTOGRAPHY

My Favorite Camera. Photo Era, 63 :258, Nov., 1929.
Shutter Speed Testing for Amateurs. Photo Era, 63 :246, Nov., 1929.
Sound-Film Process. Photo Era, 63 :70, Aug., 1929.
Simplified Enlarging, Photo Era, 63 :84, Aug., 1929.

RADIO

Sporting Dynamic-Speaker Ills. Pop. Sci. Mo., 116 :2 :70, Feb., 1930.
World Weather News by Radio. Pop. Mech., 53 :50, Jan., 1930.

SCIENCE TEACHING

The Results of Certain Experiments in the Teaching of Chemistry to College Students. Jo. Chem. Ed., 6 :1740, Oct., 1929.
Increasing the Usefulness of Short Focus Projection Lantern. Parts I and II. Jo. Chem. Ed., 6 :1638, and 1928, Oct. and Nov., 1929.
Present Specific Objectives in High School Chemistry. Jo. Chem. Ed., 6 :1958, Nov., 1929.
Our Changing Education, Jo. Chem. Ed., 6 :1940, Nov., 1929.
Symposiums on Lecture Experimentation. Jo. Chem. Ed., 6 :1882-1915, Nov., 1929.
The Application of Psychology to the Teaching of High School Chemistry. Jo. Chem. Ed., 6 :2181, Dec. 1929.
First Year College Chemistry. Jo. Chem. Ed., 6 :2189, Dec., 1929.
The Status of Chemistry and the Chemistry Teacher in the Ohio High Schools. Jo. Chem. Ed., 6 :2196, Dec., 1929.
A Comparison of Two Methods of Teaching One Problem in General Science. School Rev., 38 :61, Jan. 1930.
Present Day Trends in the Teaching of Nature Study. Nature and Sci. Ed. Rev., 2 :1, Oct., 1929.
Training for Nature Service in Teachers College. Nature and Sci. Ed., 2 :13, Oct., 1929.

SHIPS

Sailing Down the Centuries. Pop. Sci. Mo., 116 :1 :33, Jan., 1930.

TELEVISION

Transmission of Television Images. Radio, 11 :36, Dec., 1929.
Television's Progress. Sci. Amer., 141 :487, Dec., 1929.
The Latest in Television. Pop. Mech., 52 :472, Sept., 1929.


CHICAGO APPARATUS CO.

Summer Courses for Science Teachers

CHARLES J. PIEPER

School of Education, New York University

The courses for science teachers listed below were reported by directors of summer sessions in state universities, schools of education, and teachers colleges in answer to a recent questionnaire. From the returns there have been selected those courses which appeared to be especially planned as professional courses. Subject-matter courses in the special sciences have not been included in the list for lack of space. Titles of courses, dates, and names of instructors are given. More complete information is obtainable in the catalogs of the various institutions. The list is arranged alphabetically by states.

University of Alabama, University, Alabama.
(First term, June 9 to July 18; second term, July 18 to Aug. 22.)
- Materials, Methods and Directed Teaching of High School Science—1st or 1st and 2nd — C. M. Pruitt
- Problems in the Teaching of Science—1st or 1st and 2nd — C. M. Pruitt
- General Science for Teachers—1st or 1st and 2nd — C. M. Pruitt

Colorado State Teachers College, Greeley, Colorado.
- General Science—June 14 to Aug. 23 — Edith M. Selberg
- Elementary Science—June 14 to Aug. 23 — Edith M. Selberg
- Teaching of Science—June 18 to July 2 — S. R. Powers
- Teaching of Chemistry—June 14 to Aug. 23 — W. G. Bowers
- Methods of Teaching High School Physics—June 14 to Aug. 23 — C. F. Valentine

University of Colorado, Boulder Colorado.
- History of Biology—June 23 to July 26 — W. W. Greulich
- Literature of Biology—June 23 to July 26 — Francis Ramaley
- Teaching of Chemistry in High Schools—June 23 to July 26 — Glen Wakeham

Yale University, School of Education, New Haven, Conn.
- Nature Study—June 30 to Aug. 8 — R. F. Lund
- Science for Elementary Teachers—June 30 to Aug. 8 — R. F. Lund
- Biology for Junior and Senior High School Teachers—June 30 to Aug. 8 — F. A. Riedel
- General Science for Junior and Senior High School Teachers—June 30 to Aug. 8 — F. A. Riedel
- Teaching of Science in Junior and Senior High Schools—June 30 to Aug 8 — F. A. Riedel

University of Florida, School of Education, Gainesville, Florida.
- Materials and Methods—June 16 to Aug. 8 — F. H. Heath

University of Georgia, Athens, Georgia.
- Teaching Agriculture—June 23 to Aug. 2 — C. C. Aderhold
- Geography and Nature Study for Grades—June 23 to Aug. 2 — D. L. Earnest
- Visual Instruction—June 23 to Aug. 2 — D. L. Earnest

University of Chicago, School of Education, Chicago, Illinois.
(First term, June 16 to July 23; Second term, July 24 to Aug. 29)
Supervision of Science Teaching—1st or 2nd W. L. Beauchamp
Materials and Methods of General Science—
1st or 2nd or 1st and 2nd O. D. Frank
Introduction to the Teaching of Science—
1st or 2nd or 1st and 2nd O. D. Frank
Technique of Teaching Science—1st or 2nd
or 1st and 2nd E. R. Downing
The Science Curriculum—1st or 2nd
or 1st and 2nd E. R. Downing
Primary School Methods: Nature Study—1st Ada Polkinghorne
Evansville College, Evansville, Ind.
Supervised Teaching of Science—June 16 to Aug. 9 H. L. Humke
Indiana State Normal School, Terre Haute, Indiana.
Teaching of Science in High School—July 16 to
July 18 L. J. Rettger
Teaching of Science in the High School—June 21 to
Aug. 22 Walter Woodrow
Drake University, Des Moines, Iowa.
General Science—June 10 to Aug. 9 R. Davies
University of Iowa, School of Education, Iowa City, Iowa.
Biology of Plants—June 9 to July 17 E. C. Angst
Plant Science Today—June 9 to July 17 W. Loehwing
Teaching of Chemistry—June 9 to July 17 P. A. Bond
Teaching of High School Physics—June 9 to July 17 Mr. Bail
Teaching of Zoology—June 9 to July 17 H. F. Wickham
Teaching of Physics—July 21 to Aug. 21 Mr. Bail
Kansas State Teachers College, Emporia, Kansas.
Nature Study—June 1 to July 30 F. U. G. Agrelius
Elementary Natural Science—June 1 to July 30 John Breukelman
Elementary Science—June 1 to July 30 J. P. Drake
Visual Education—June 1 to July 30 J. P. Drake
University of Kansas, School of Education, Lawrence, Kansas.
Teachers Course in Natural Science—June 11 to
July 19 E. E. Bayles
Kansas State Agricultural College, Manhattan, Kansas.
School Gardening—June 1 to Aug. 1 Mr. Balch
Problems in Botanical Instruction—June 1 to
Aug. 1 Dr. Haymaker
Laboratory Technic—June 1 to Aug. 1 Mr. Floyd
Special Methods in Teaching of Physics—June 1 to
Aug. 1 Mr. Floyd
Johns Hopkins University, Baltimore, Md.
Chemical Education—June 30 to Aug. 8 N. E. Gordon
Contemporary Chemistry Teachers and a Comparative Study of Chemical Development—
June 30 to Aug. 8 N. E. Gordon
Recent Advances in Chemistry—June 30 to Aug. 8 N. E. Gordon
Principles of Organizing and Teaching Social and
Natural Sciences in Secondary Schools—
June 30 to Aug. 6 W. K. Kluigaman
Harvard University, Cambridge, Mass.
Teaching of Physics—July 7 to Aug. 16 H. W. LeSourd
Teaching of General Science—July 7 to Aug. 16 H. W. LeSourd
Massachusetts Institute of Technology, Cambridge, Mass.
Methods of Teaching General Science in Junior and
Senior High Schools—July 7 to Aug. 1 J. R. Lunt
Methods of Teaching Physics in Senior High Schools—
July 7 to Aug. 1 F. R. Miller

Methods of Teaching Chemistry in Senior High Schools—
July 7 to Aug. 1 — W. C. Schumb
General Science Laboratory—July 7 to Aug. 1 — J. R. Lunt
Methods of Teaching General Biology—July 7 to August 1 — Eva B. Ammidown
Health Education Methods—July 7 to Aug. 1 — Juliet O. Bell

School of Education, Ann Arbor, Michigan.
Teaching of Science in the Junior and Senior High School—June 30 to July 21 — F. D. Curtis
Seminar: Problems in the Teaching of Science—July 21 to Aug. 22 — F. D. Curtis
Teaching of Physics—June 30 to Aug. 22 — G. W. Fox

University of Minnesota, School of Education, Minneapolis, Minn.
Teaching of High School Science—June 17 to July 26 — H. O. Jackson
Teaching of High School Physics—June 17 to July 26 — H. O. Jackson

University of Missouri, Columbia, Mo.
Teaching of General Science—June 9 to Aug. 1 — R. K. Watkins
Research in High School Teaching — R. K. Watkins
Fundamental Concepts of High School Physics—June 9 to Aug. 1 — H. E. Hammond

University of Nebraska, Lincoln, Nebraska.
Teaching of Biology — P. G. Johnson
Teaching of Chemistry — P. G. Johnson
Teaching of Physics — Earnest Armstrong

Rutgers University, New Brunswick, N. J.
Elementary or General Science—June 30 to Aug. 8 — N. B. Carhart
Nature Study—June 30 to Aug. 8 — N. B. Carhart

Columbia University, Teachers College, New York City.
Teaching and Supervision of Science—July 7 to Aug. 15 — S. R. Powers
Teaching Science in Elementary Schools—July 7 to Aug. 15 — G. S. Craig
Illustrative Lessons in Science for the Elementary School—July 7 to Aug. 15 — G. S. Craig
Recent Developments in Science—July 7 to Aug. 15 — (Staff)
Teaching of Sciences in Elementary and Secondary Schools in England—July 7 to Aug. 15 — W. H. Perkins
Teaching General Science in Secondary Schools—July 7 to Aug. 15 — H. J. Arnold
Demonstration Class in Junior High School Science—July 7 to Aug. 15 — A. I. Lockhart
Teaching Biological Sciences in Secondary Schools—July 7 to Aug. 15 — M. E. Oakes
Teaching Chemistry in Secondary Schools—July 7 to Aug. 15 — A. I. Lockhart
Teaching Physics in Secondary Schools—July 7 to Aug. 15 — H. E. Brown
Field Studies in Science—July 7 to Aug. 15 — M. E. Oakes
Field Studies in the Physical Sciences—July 7 to Aug. 15 — H. E. Brown

Cornell University, Ithaca, New York.
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Physiology and Health Education—July 5 to Aug. 15 — D. F. Smiley
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Nature Study—July 5 to Aug. 15 — E. L. Palmer

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- Teaching of Elementary Science—July 7 to Aug. 15 — L. M. Dougan
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- Investigations in the Teaching of Science—July 7 to August 15 — C. J. Pieper

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- Teaching of General Science—July 1 to Aug. 8 — Mr. Humphrey

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- General Science—June 16 to August 15 — A. W. Boetticher

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- Local Flora—June 23 to Aug. 1 — E. C. Persing and R. Peterson
- General Science—June 23 to Aug. 1 — E. C. Persing and V. R. Peterson

Western Reserve University, Nature Guide School of the School of Education.
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- Local Flora—June 21 to Aug. 1 — M. E. Turner
- Birds—June 21 to Aug. 1 — J. W. Hadley
- Handcraft—June 21 to Aug. 1 — L. H. Baxter
- Agriculture—June 21 to Aug. 1 — R. B. Simon
- Outdoor Leadership—June 21 to Aug. 1 — W. G. Vinal
- Gardening—June 21 to Aug. 1 — M. E. Turner
- Practicum in Nature Education—June 21 to Aug. 1 — Staff

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- Methods and Problems of the Natural Sciences—July 24 to August 29 — G. R. Twiss
- Methods and Problems of the Physical Sciences—July 24 to August 29 — G. R. Twiss
- Teaching of Chemistry—July 24 to August 29 — G. R. Twiss
- Teaching of Physics—June 17 to July 23 — G. R. Twiss

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- Special Problems in Science Education—July 1 to Aug. 8 — Jasper Shriner
- Nature Study—July 1 to Aug. 8 — George Free

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- Teaching High School Physics—June 18 to July 30 — C. F. Mercer

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- Special Methods in Agricultural Teaching—June 9 to Aug. 27 — Mr. Hull
- Supervision of Vocational Agriculture—June 9 to Aug. 27 — Mr. Davis and Mr. Smith
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- Nature Study—June 9 to August 27 — Mrs. Walker
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- Directed Teaching and Observation in High School Chemistry—July 19 to Aug. 27 — Mr. Herndon
- Materials and Methods for Teaching Chemistry in Teachers Colleges—June 9 to August 27 — H. A. Webb
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- Materials and Methods of Teaching Elementary Science—June 6 to July 18 — H. B. Allen
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- Hygiene and Sanitation (for teachers)—June 6 to July 18 — M. L. Bonar
- Nature Study (for teachers)—June 6 to July 18 — L. M. Peairs

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- Investigations in the Teaching of Science—June 30 to August 8 — I. C. Davis
- Teaching of General Science—June 30 to August 8 — I. C. Davis

State Teachers College, Oshkosh. Wisconsin.
- Curriculum Materials and Technique of Teaching General Science—June 24 to Aug. 1 — J. O. Frank
- Curriculum Materials and Technique of Teaching High School Sciences—June 24 to Aug. 1 — J. O. Frank

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NEWCOMB & GAUSS CO., Printers, Salem, Mass.